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BULLETIN OF THE

TAYLOR SOCIETY

AN INTERNATIONAL SOCIETY TO PROMOTE THE SCIENCE AND THE ART OF ADMINISTRATION AND OF MANAGEMENT

> IT IS the business of total situation psychology in industry to investigate and to eliminate conditions which lead to disharmony in the individual's mental background, and to promote that orientation which alone makes reasoned adjustment to the job possible.—Page 255.

Engineering Societies Building
29 W. Thirty-Ninth St.
New York

DECEMBER, 1924 VOL. IX, NO. 6

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BULLETIN OF THE
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VOL. IX DECEMBER, 1924 No. 6

Contents

Comment 237
Samuel Gompers 239
Scientific Management Can Double Wages 241
By Irving Fisher
The Social Meaning of Good Management 242
By Mary Van Kleeck
What Industrial Psychology Asks of Management 243
By W. V. Bingham
Annual Business Meeting 248
The Basis of Industrial Psychology . . 249
By Elton Mayo
The Achievements of Motion Psychology 259
By Frank B. and Lillian M. Gilbreth
Production Control 260
By George D. Babcock
Planning and Production Control . . 271
By Committee on Industrial Planning, Boston Chamber of Commerce
Reviews 285
Necrology 288

To Richard A. Feiss, Past President

Our grateful acknowledgments. Under your leadership the Taylor Society has grown in size, in quality of service and in public esteem. May we remind you that to have been President is to have qualified for larger service on behalf of the Society.

To Percy S. Brown, President

Our greetings. As a plant manager you have given American industry a noteworthy example of precise and economical management. As Chairman of a Section of the Taylor Society you have won the blue ribbon. We offer a willingness to follow which is a challenge to your leadership.

Comment

FOR the benefit of those members who were unable to be present we are happy to report that the annual meeting—New York, December 4 to 6—is appraised by many members as a distinct success. The attendance was well over 500. Every session held something of interest and of value, and some sessions made contributions of outstanding importance. In this issue are printed three of the leading papers, a brief report of the business meeting, and two of the addresses at the dinner. The next issue will present other addresses and leading papers.

IT WAS a fortunate circumstance that the meeting could follow so closely the meeting of the A.S.M.E. —so closely that the last day of the A.S.M.E. meeting and the first day of the Taylor Society meeting could overlap in a joint session. The Management Division of the A.S.M.E. and the Taylor Society have common problems and many members in common. The Taylor Society unquestionably derives considerable advantage, and the Management Division of the A.S.M.E. probably some advantage, from the holding of joint sessions. We hope, therefore, that the Management and Shop Practice Divisions of the A.S.M.E. will hold joint sessions with the Taylor Society every December.

THE business meeting was the most successful which the Society has held since the historic meeting of 1919 in Keen's Chop House, at which Miss Margaret Bonfield of England, Miss Kerstin Hesselgren of Sweden and M. Charles deFreminville of France were guests. The hall in which the dinner and meeting were held — at the Fraternity Club — afforded precisely the suitable environment, and the reports of the officers and addresses and informal talks were of a high order. Although serious matters were presented and considered, confidence in the future characterized all the discussion. The sixty-five members who were present — an even balance of younger members and older members of national prominence—constitute a group in which the Society has a right to have pride.

BY A natural order of events and without malice aforethought, the Society is asking the younger members to assume a larger share of responsibility in the conduct of its affairs. The new President — Percy S. Brown, Works Manager of the Corona Typewriter Co., Inc., Groton, N. Y.—by his achievements as plant manager, and his energy as Chairman of the Central New York Section of the Society, has won this responsibility at a comparatively early age. Two of the newly elected members of the Board of Directors are even younger. The Board of Directors is happily balanced as to age and experience—energy and wisdom in counsel and energy and skill in administration. There is in the situation a challenge to all the younger members of the Society to give evidence of realization of their age-group responsibility by intensive activity in Society national and sectional affairs. Evidence of their interest and willingness is already apparent. The experiment, at the recent meeting, of a session planned and conducted by and for the younger members proved to be highly successful. In excellence of planning, importance of the papers and discussion, competence of the presiding officer—in every respect—this younger members' session ranks with the best which has been offered by the Society. It proved its right to become a permanent element of every meeting.

FORTY-TWO educators concerned in the teaching of management were registered at the annual meeting. In addition to these a number of other persons less directly concerned in the same matter attended the session—the first of its kind—organized especially for that professional group. The papers and discussions were substantial in content, and the teachers who were in attendance decided that a similar special session should be a feature of each annual meeting. The distinguishing characteristic of the session organized by the Taylor Society was the bringing together of teachers of management from engineering schools and schools of commerce respectively. The two groups have a common problem—the teaching of management—but each has also a special problem in the solution of which the other can help; engineering school teachers are giving thought to the problem of introducing certain commerce courses into their curricula and commerce school teachers are giving thought to the problem of introducing certain engineering courses into their curricula. In an institution of the university type in which there are both an engineering school and a school of commerce, the problem is especially important. An adequate solution should be found if both groups of teachers consider the problem *together*. In another issue we shall have something to say about the teaching of management which was suggested by the discussions at this session.

ASIDE from the content-value of the papers and discussions there were many interesting features of the meeting. The discussions of the first day were focused upon the Taylor philosophy, principles and system of management. The matter-of-factness with which scientific management and the Taylor System were mentioned in discussion was evidence of a new comprehension and of a consequent new attitude of mind. As Mrs. Gilbreth remarked, the day of controversy has passed and the day of comprehension, adaptation and utilization has arrived. The evidence is accumulating that the Taylor philosophy is the accepted basis of progressive management thinking, and the Taylor mechanisms the accepted basis of progressive management systems. (It matters little whether the thinker or doer appreciates the historic origins!) And as Mr. Kent observed in the course of his remarks at the annual dinner, there is in this a reason for gratification on the part of that thin line of students of management in the Taylor Society who during the past fifteen years, and especially during the first five of these, have stood fast for those ideas and practices which were bound ultimately to be accepted as basic in American management.

IN THE course of the meetings the scientific management attitude towards the problem of industrial relations stood out in new perspective and was consequently better comprehended by casual guests. During the joint session George Babcock and others answered effectively the criticisms of scientific manmanagement in respect to relations with workers. Scientific management believes that good industrial relations arise out of a manner of conduct, not out of everlasting talking. Good industrial relations result from a management that knows what it is doing; a management that makes plans, gets orders, regularizes employment, operates precisely and economically—in other words, does the things which maintain it as a going concern; that brings all the resources of the scientific method to bear on its problems; that establishes contractual relations on the basis of all the facts that are ascertainable; that takes operatives into its confidence and secures approval with respect to details of standard method, time and rate; that enhances individuality in team work instead of minimizing it in mob effort; and that—not least—increases social income. In the course of her remarks at the annual dinner, Miss Mary Van Kleeck made the observation that her early interests were in social problems rather than in management problems, but that she had been attracted to and become vitally interested in scientific management and the Taylor Society because her early observations in social work had convinced her that better technical management is the solution of many of the social problems. And in his remarks at the annual dinner, Professor Irving Fisher observed that one thing in scientific management—genuine scientific management, not mere efficiency management—which impresses him profoundly is the possibility of marked increase of real wages through the greater productivity of such management.

MANAGEMENT'S interest in psychology is a by-product of its interest in human relations. Scientific management and the Taylor Society have taken up the challenge of this interest, and in two sessions (one in April, one in December, 1924) have made a contribution to the literature of *industrial* psychology, have brought psychologists and managers into closer contact, and have stimulated inquiry, exposition and thinking along fundamental lines. Statistics and frequency tables of conduct in the industrial environment constitute a line of inquiry of which the value cannot be overestimated, but that is not sufficient. It is essential to inquire into the nature and range of the stimuli which cause the conduct which is counted. What are the stimuli to conduct in industrial relations? To what extent can those stimuli be modified? That is a fundamental question, for if the environment can be modified so as to substitute stimuli to conduct expressive of greater happiness and good will, it is management's task to bring its influence to bear towards favorable modification of the stimuli. Even if management cannot effect great changes in the stimulating environment, just to know what the stimuli are will enable it to manage more wisely and effectively. Mr. Mayo's paper, one of the papers printed in this issue, is an inquiry along these lines. It focuses our attention for the time being on the "psychology of the total situation." It was received with marked interest, for his audience realized that his point of view had a strong basis in observation and experiment under actual plant conditions which checked with their experience as managers. We know of one works manager who went back to his plant and re-hired a discharged worker because at the time of his discharge elements of the total situation had not been taken adequately into consideration.

Samuel Gompers

IN THE passing of Samuel Gompers American industry loses a leader who has made history.

An immigrant youth of humble parentage and without educational advantages, he developed into a man of genuine culture, a speaker and writer of clear and vigorous style, the creator of a powerful institution to protect and promote the interest of workers as a group, and eventually the advisor of statesmen in matters pertaining to industrial welfare. And like a statesman he was buried, government and industry rendering honor to the great leader of labor.

He was a great leader of labor. His efforts of leadership met the pragmatic test—they were successful because they matched the industrial circumstances of his day. The American Federation of Labor is a powerful institution today because it was at the beginning well organized to meet the conditions which determined its purpose. It could not have grown so steadily, could not have acquired and retained its power over a period of forty years, had its organizers not at the beginning sensed a need of American workers and as time passed taken cognizance of the development of that need. From the point of view of one decade it may have seemed too radical in its ideals, and from the point of view of another decade, too conservative—but steadily it grew more powerful. This could not have been the fact had there not been somewhere in the background the steadying force of a genius in analyzing industrial conditions and tendencies in their relation to the aspirations of labor, and genius of leadership in directing labor towards organized self-realization and self-expression.

He was an industrial statesman. His ideal was human welfare—construction, not destruction. But because he was a man of affairs who sought the ultimate ideal by solution of problems as they came to him one by one, his reactions had to be such as to meet the actual situations present in the environment of his day. His methods of solving these incidental problems were determined by the nature of the obstacles and the methods of opponents. In the earlier days of the Federation circumstances compelled militancy, and circumstances are not yet such as to assure the Federation that it can now safely discard militancy; but of late years there has been more of an attitude of "speak softly and carry a big stick"; more and more an attitude of cooperation with other group interests. Just a year ago we called attention to this attitude of cooperation, which has in it promise of integration, in the following words:[1]

> There is occasion for grave concern that the declarations of organized bodies representative of finance, ownership and management are as a rule limited to generalization such as "less government in business and more business in government," without supporting studies showing why more government in business has come about and how less government in business is to be achieved. There seems to be an absence of historical sense of the reasons for the present situation and of constructive imagination with respect to the way out. There is apparently little concern on the part of ownership and management that the way business has been managed—with respect to controlling motives and practice—is probably the cause of the situation which business feels to be so unsatisfactory, and that the remedy undoubtedly lies in the way business is going to be conducted—again with respect to controlling motives and practice. Experiencing the ill effects of an unfavorable regimen, ownership and management disregard the proved methods of diagnosis, prognosis and prescription and cry out for a Coué to lead them to health through a formula.
>
> On the other hand, certain recent declarations of organized labor give evidence of a thinking about the reasons for the present situation and a way out. Among many declarations and resolutions adopted at the October convention of the A. F. of L. at Portland, Oregon, was one entitled "Industry's Manifest Duty." One may not agree with all in that declaration, but one must recognize its substantiality, and acknowledge that it presents basic principles of a positive program of cooperation with ownership and management. Its constructive vision is evidenced by the fact that it recognizes that the ills of industry are a result of the habits of industry, and that the cure for those ills must come from a change of habits.

The Society stands for the philosophy, principles and technique of scientific management; Mr. Gompers opposed these in an earlier day; yet we appraise him as a great leader and industrial statesman. While we believe Mr. Gompers was in error in his earlier attitude and failed to seize promptly a great opportunity for promoting the very industrial welfare he sought, we have thought none the less highly of him on that account. Even great men are human and are privileged to err. What great leader has not made his mistakes? And possibly it may prove to have been well for scientific management that the Federation erred in its first judgment. Scientific management in its first expositions was explained too narrowly. Even its advocates failed in those days to appreciate all its implications. The fact that they were put on the defensive may have been good for them and for it. At any rate, the files of this Bulletin prove that the advocates themselves, in sustained efforts towards clearer exposition, have learned something more about the ideals of their great leader and about scientific management. If that which is opposed has something basic which meets a great human need, it has no cause to fear opposition; it is refined and strengthened by honest, intelligent opposition. From that point of view the Federation's opposition has probably helped scientific management—certainly more than has the opposition of certain classes of ownership and of management which has been less reasoned. And if that which is opposed has something basic for industrial progress, it gradually wins those who honestly and reasoningly oppose. The Federation apparently is gradually being won. In an article in the *Annals of the American Academy of Political and Social Science,* September, 1920, the recognized spokesman of organized labor in this country—Mr. Gompers himself—took an unequivocal stand for greater production as being in the interest of the wage earners. It was a momentous decision:

> Production is the great world problem of today.
>
> We cannot escape the problem of production. We must meet it and come as near to a solution as may be possible, or we shall suffer.
>
> We are face to face with no simple problem. No magic will remove the tangle.
>
> Mere expenditure of more muscle power will not bring us out of the difficulty.
>
> It is the intelligent coordination of effort and the proper reward of effort that we must arrive at.

When the time comes, as come it surely will, when organized labor openly accepts scientific management as *its* means of achieving industrial welfare, labor will have made the next and the most momentous decision looking towards Mr. Gompers' ideal of "a higher, fuller, finer life, with more of freedom and more of self-expression for all."

Mr. Gompers began his constructive work on behalf of labor with the beginning of large-scale industry as we now know it. He was a pioneer solving new problems of adjustment in a pioneer way. A great "vigilance committee," watchful of the interest of labor, is his monument. But Mr. Gompers himself came to see that conditions, problems, mental attitudes, opportunities and responsibilities had changed—that orderly government in industry is now the goal. We hope that the new leadership will do the work of its day as well as Mr. Gompers did the work of his day.

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[1] *Bulletin of the Taylor Society,* Vol. VIII, No. 6, December, 1923, p. 206.

Scientific Management Can Double Wages[1]

NOT since as a boy I read Robinson Crusoe have I been thrilled by a story of adventure as when recently I read Copley's life of Taylor. Frederick W. Taylor was not only a great man and a great pioneer; he was a great benefactor of the human race.

As an economist I would stress particularly the value of scientific management to labor. When the time comes, as come it must some day, when scientific management is no longer the precious possession of a few only; when the works of its imitators and betrayers who, a few years ago, gave it a black eye, are no longer confused with the genuine article as exemplified by Barth and members of this society generally; when the control of industry is more fully in the hands of those who are not concerned in getting rich quickly but in the slow substantial progress which scientific management necessarily implies; when as a matter of course scientific management is as universal as the telephone or newspaper — I have little doubt that the welfare of labor will be double; in short, that real wages will be twice as high as at present.

In saying this I have no reference to the direct and immediate increase in money wages to the lucky few who work under scientific management on a rational system of task and bonus. I mean something far more fundamental though indirect. Even if it were possible for employers at first to "hog" all the savings accruing from scientific management and refuse to give any bonus to labor, in the end the advantages would percolate throughout society just as today we all get the advantage of the telephone despite the enormous returns to the few original investors. In the end labor gains the most from so-called "labor saving devices." Increased production means simply increased income to society, and the wage earner as a class usually profits the most in the end. Scientific management by which the bricklayer doubles or quadruples the number of bricks laid, reduces the rent of brick houses. Scientific management which makes more shoes and clothes decreases the real cost of shoes and clothes to all. Real wages consist of shoes and clothes and shelter and food and the other things which labor consumes. Any device which facilitates their production tends to increase real wages.

This seems extraordinary to those who have not followed scientific management, just as several years ago the statement of one of Mr. Brandeis' witnesses seemed extraordinary when he claimed the railways of America could save a million dollars a day by scientific management. But the proof that scientific management can more than double average productivity now fills management literature. And we should take account of the incidental inventions to which scientific management leads. The Taylor-White high-speed steel enabled the United States during the war to turn out five times the munitions that it otherwise could. And yet we have only scratched the surface of what scientific management can do.

The Taylor Society has the great mission of improving the general well-being of mankind by which labor as well as the rest of us can enter the promised land flowing with milk and honey at a rate double the present flow.

As Mr. Babcock, one of our greatest practical exponents of scientific management, has said this evening, the universities can play a part in this great movement. Engineering, though originating in industry, had to pass through the university to receive its highest scientific formulation, and then the universities handed back to industry thousands of educated young men to become engineers; likewise today, industry, in which scientific management began, needs to hand over to our universities the task of educating young men in Taylor's principles. My own university, Yale, is making a start in this direction, as have several other universities like Harvard, Pennsylvania and Dartmouth. Our progress will be slow because impeded by prejudice, ignorance and indifference, as progress ever is and must be. The worst tragedy is the opposition of so many misguided labor leaders who hold a philosophy the opposite of Taylor's and insist on limitation of output and reduction of the flow of milk and honey. "Making work" in this way reduces real wages to the average laborer.

But employers before they blame labor for ignorance and prejudice should first take the beam out of their own eye. For they have set bad examples in creating artificial scarcities and seeking "protection" from competition, to say nothing of angering labor by cutting piece rates and robbing the individual workman of the necessary incentive to increase production. Both capital and labor are injuring themselves by squabbling over distribution instead of joining in production. The distribution struggle in Russia has ended in Bolshevism, which has reduced production as startlingly as Taylor's scientific management would increase it.

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[1] Abstract of an extemporaneous address by Irving Fisher, Professor of Political Economy, Yale University, at the dinner of the annual business meeting of the Taylor Society, New York, December 4, 1924.

The Social Meaning of Good Management[1]

I SHALL limit my remarks to an attempt to show the significance of the Taylor Society in my own experience. This I do, not as a means of enlightening any of you, but in the hope of stimulating each of you to evaluate once more the meaning of the Society.

I was keenly interested in the discussion at the morning session in which, as in previous meetings, several speakers talked about "the new recognition" of "the human element in industry." They seemed to think that this was lacking in the first formulation of the principles of scientific management.

I should like to turn the subject completely around. My own experience began with what is called the human element in industry, and I saw it at first outside the shop in the community. In the lives of wage-earners, particularly women in industry, I saw the effects of long hours of work, unemployment, and low wages. In the search for remedies, I was led back into the causes of these conditions in the shop itself, and nowhere did I find so many questions in process of being answered as in the Taylor Society. Not the final answer but the process of discovering the answers was for me the big contribution of this group.

Those answers did not relate merely to what is called the human element in industry, conceived as a separate problem in a different compartment of the manager's desk. My interest in the contribution of scientific management to the social problems in the lives of wage earners was not solely in its emphasis upon personnel relations, but in the technical organization of industry as it affects wage earners. The constructive imagination which can spend seventeen years studying the art of cutting metals is the imagination which can make industry and all its results in human lives harmonize with our ideals for the community. That kind of constructive imagination, though it may deal with one technical problem, will not fail to envisage the whole significance of industrial management. Nor will it be content merely to increase profits. The philosophy and the procedure which it represents will ultimately build a shop whose influence in the community will be social in the best sense, because the shop and all its human relations are built on sound principles.

Therefore, my interest in the Taylor Society is not directed toward challenging the technical engineer to give attention to problems of human relations. I am not worried about that, because if he is a good engineer he cannot fail to contribute to human relations. I am concerned rather with the other end of the story. I am eager to have those people who see in the community the present disastrous results of industrial organization realize how the art of management in the shop can fundamentally change those social conditions in the community. The Taylor Society can thus interpret management to the group who are seeking to construct a better community. Membership in the Taylor Society means an opportunity to share in that interpretation.

I can illustrate in another way what membership in the Taylor Society means. I have in my mind a picture of the Taylor Society in session. A valiant member rises with tilted spear to advance upon the rest of us. He has discovered a new idea which was lacking in Mr. Taylor's formulation of principles. He hurls his challenge. I see members of the old guard sitting on the front row, and I observe over the collar the tip of a smile. The smile means: "If this young man will think a little more deeply, he will find his idea already formulated in scientific management, but we won't tell him so." For this is what the Taylor Society is for. It makes just one claim upon its members—the claim to understanding by each member for himself. To the man who asks, "What shall I get out of membership in the Taylor Society?" the answer is simply "a challenge to think for yourself and to test your thinking in actual practice." Membership in the Taylor Society does not mean simply paying dues in order to receive a bulletin and to share in other attractive perquisites of an ordinary society. It means a readiness to accept a challenge presented in the discovery and formulation of principles of management which have a lasting value because they stimulate the conflict of ideas.

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[1] Abstract of remarks by Mary Van Kleeck, of the Russell Sage Foundation, at the dinner of the annual business meeting of the Taylor Society, December 4, 1924.

What Industrial Psychology Asks of Management[1]

Patience, Discrimination, Research Opportunities, Reliable Criteria

By **W. V. BINGHAM**
Director, Personnel Research Federation[2]

PSYCHOLOGISTS and management engineers are drawing together. They are becoming more aware of each others' problems and points of view. Increased cooperation has been proposed. If this is to be accomplished, psychologists have four things to ask of management — patience, discrimination, research opportunities and reliable criteria. Of these, the fourth is basic and implies more than may at first appear. But before examining these four requests in detail, let us get a fresh picture of the type of problem in which management and psychology are both interested.

What many a manager wants to know is why his workers do not produce more. He is aware that the answer is not always found in such things as defects of planning, routing, machine speeds, or in working conditions, or in insufficient financial rewards and incentives. The employees may, perhaps, be facing unrecognized difficulties in acquiring the high degree of skill needed to do the work in the best way or in any very rapid and accurate way — a problem on which the educational psychologist should be of help.[3] There may be obscure factors producing unnecessary fatigue with its accompaniments of irritation, dissatisfaction and outbursts of temper — a problem with psychological as well as physiological and engineering aspects. The British psychologists who in 1922 worked for seven months in coal mines to study the miner and his work were able to increase both the comfort of the miner and his output of coal by reducing the glare from his lamp; thus getting rid of troublesome visual after-images; by modifying the rhythm of the swing of his pick, and by getting him to strike harder and more slowly when working at the coal-face, and to use a quicker, lighter stroke in digging the harder "dirt."[4] These investigators were primarily interested in the psychological aspects of the miner's work, but they did not hesitate to study that work as a whole, in the mine as well as in the dark-room of the psychological laboratory. When other British psychologists studied the causes of excessive breakage[5] of dishes in a catering firm, they found that in large part the costly accidents were traceable to worry, irritation and fatigue, and particularly to emotional tension of the workers at rush hours. This tension was not so often carried past the breaking point after the employees were forbidden to shout their orders to each other. Partitions were built to make some of this shouting impossible, and the personal element was eliminated by the use of a mechanical indicator. The savings in broken dishes and glassware—about 53 per cent on the average—effected by this combination of statistical analysis, psychology and common-sense management have already amounted to many times the cost of the investigation; and the terms "carelessness," "accident" and "poor material" have been stricken from the list of adequate explanations of the cause of many breakages.

Since the founding in London in 1921 of the National Institute of Industrial Psychology, our British colleagues have made studies in a wide variety of industries. These include a tin box factory, a cabinet factory, chocolate factories, a bakery, a catgut factory, a starch factory and a tobacco factory. They have made investigations for cotton mills, calico printers, and margarine makers. They have studied hand composition in a printing plant. They have done research on selection of learners of dress-making, of the machine trades, and of certain clerical occupations. From the psychological point of view, and as a result of study by means of psychological techniques, these men of science have made useful suggestions to managers of tea warehouses, laundries, oil works, glass works, and railways.[6]

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[1] A paper presented at a meeting of the Taylor Society, New York, December 5, 1924.

[2] Formerly Professor of Psychology, Carnegie Institute of Technology.

[3] See Chapter IV of "Skill in Work and Play" by T. H. Pear, London; Methuen & Co., 1924.

[4] "An Investigation in a Coal Mine," by E. Farmer, S. Adams and A. Stephanson, *Journal of the National Institute of Industrial Psychology,* Vol. I, No. 4, October, 1922, page 125; Vol. I, No. 5, January, 1923, page 178; Vol. I, No. 6, April, 1923, page 232.

[5] "An Investigation into Breakage Problems," by G. H. Miles, A. B. B. Eyre and others, *Journal of the National Institute of Industrial Psychology,* Vol. I, No. 4, October, 1922.

Meanwhile in America psychologists interested in the technical applications of their science have devoted themselves chiefly to problems arising in the schools. Some are active in commercial applications of psychological methods and facts, but only a few of these have been primarily concerned with problems of industry as distinct from business. Several psychologists have studied advertising, made analyses of appeals and proposed ways of measuring the relative effectiveness of these appeals in advance of publication. They have studied the psychological aspects of the laws against infringement of copyright in order to establish objective standards of allowable similarity of trademarks and trade-names. More psychologists have been concentrating on problems of selection, development and supervision of personnel, particularly of clerical and sales personnel. We shall see later some of the difficulties these investigators have faced, discouragements which can be overcome by the cooperation of employers and engineers imbued with the spirit of truly scientific management. Let me describe a case in point.

Last summer a former student of mine was asked to help clear up a difficult situation in a department of a factory where, in comparison with other departments in the same building, labor turnover was high and output discouragingly low. There were 90 employees in the department, mostly young men from 19 to 25 years of age. The work was that of soldering wires to strips of jacks. This is not easy to do rapidly and skillfully; but beginners can get started on actual production within a few days and can be earning bonus in four or five months. They are guaranteed a good hourly rate from the start, but are an expense to the company until they have acquired skill and speed enough to be making piece rate. In spite of what seemed to be adequate financial incentive, good working conditions and diligent efforts of supervisors and foremen, too many of the men left for other jobs, and too few of those who stuck to their work earned any bonus. The management raised several questions. Were they hiring the right type of worker for this department? The employment office was choosing bright alert young men not under 19 years of age. Would a minimum age of 26 be better, or a more stolid, substantial type of worker? Could a better training program be prepared, so that the new men would make more rapid progress? Should the piece-rate be raised, or a lower level set at which the bonus incentive would begin to operate?

The investigator began by learning the job himself. Then he became supervisor of the training squad. He won the confidence of workers and management, but it was some time before the most serious single difficulty in the situation became obvious. The department was a relatively new one, and at the time it was established some of the inspectors of the product were not sufficiently experienced and competent. In the pressure for production these inspectors had passed quality which later brought complaints from users. On five distinct occasions during their first year inspection had had to be tightened. Naturally, from the worker's point of view, each sharpening of the inspector's scrutiny was equivalent to a cut in piece-rate. No wonder the investigator heard the comment, "What's the use? They don't want ye to earn no money." The forceful statements of the foreman to the contrary carried no weight in face of these facts.

Inspection in that department is now more stable. The guaranteed hourly rate has been reduced and the piece-rate raised, although no one knows to a certainty that this step was necessary. A training program has been installed, carefully planned in its details so that the progress of the new men in skill and increased output should be steady, without long discouraging plateaus during which the beginner makes no progress in speed because he has to unlearn wrong habits formed in the initial stages of learning. But months must go by before the "What's the use?" tradition is forgotten; and so long as the mental effects of that first year continue to be passed on from workers in that department to the newly hired employees, it will be difficult to carry out any really scientific experiment in selection, training or supervision of employees. To make such experiments the psychologist asks for dependable individual records of daily output or for some other measures of ability, to use as criteria against which to check the effects of improvements that are being tried. Consider, for example, the problem of finding out the effects of different types of training on this particular job.

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[6] *Journal of the National Institute of Industrial Psychology*, 1922, 1923, 1924.

Should speed be sacrificed to accuracy until after the elementary processes are well mastered, or should speed be stressed almost from the beginning of training? Do the slow initial learners ever reach a satisfactory final level of speed, or should they be transferred to other jobs as soon as their slowness in learning this one is demonstrated? Do the younger or the older applicants eventually make better workers —the small, wiry, quick-moving boys, or the large, strong, steady boys? These and a dozen other questions can some day be answered definitely by means of scientific experiment in that department, but not until the troublesome and still prevalent mental attitude of the employees has been conquered, and conditions—both in the plant and in the workers' minds—stabilized sufficiently to make output a fairly reliable criterion of each employee's actual ability and worth to the concern. The psychologist cannot establish that stability; it must be done by management.

I have said that the industrial psychologist asks of management patience, discrimination and research opportunities, as well as reliable criteria. Let us consider each of these points in turn.

1. Psychology asks management to be patient because we know that many of the most pressing problems of industrial psychology are problems in social psychology—the most backward, most speculative, least scientific branch of psychology. Forward strides have been taken by social psychology in recent years as a result of contacts with medical and clinical points of view; but not everyone recognizes how far we still are from an ideal technique of research in problems involving volitional or emotional aspects of human nature and the clash of personalities. Psychologists need time and help in learning how to measure and to mold fundamental drives and basic traits of personality and character.

We ask you to be patient because all thoroughgoing research moves slowly. The Mazda lamp of today was not developed within a month or a decade after the appearance of Edison's first incandescent light. Similarly, it has taken nearly twenty years for psychologists to bring the methods of measuring intelligence to their present modest degree of reliability and validity. It is hardly to be expected that during this year or next, psychologists, even with the heartiest cooperation of management, will be able to solve definitively any large number of the questions which are puzzling us all today.

We ask you to be patient because as yet too few psychologists have an adequate background of familiarity with industrial management. An opportunity to see some of your problems from the inside will be most helpful to psychologists in developing good judgment and insight. Some of us know only too well our limitations of familiarity with actual working conditions of plant and office management. We ask you to be patient while we are getting this necessary background.

We must ask you to be patient also with psychologists whose interest in the problems of management differs in some regards from that of the management engineer. Our methods of investigation, to be sure, are not fundamentally different from those of any science which employs analysis and measurement to establish significant correlations between phenomena. But a difference between psychologist and management engineer sometimes comes to light in the relative emphasis placed on importance of output or profits on the one hand, as against comfort and satisfactions of the workers on the other. Management engineer and psychologist are both concerned to increase output and also to increase the well-being and enduring satisfactions of the men; but the psychologist is likely to think first of how he can help adjust the worker to his work, or how he can make the work more tolerable or agreeable, trusting that there will be no diminution of profits but perhaps an increase.

Another difference in point of view sometimes shows itself when psychologist and management engineer are faced by an acute practical problem. The engineer wants to clear up the bad situation at once, introducing simultaneously as many remedies as his good judgment suggests. The psychologist, on the other hand, wants to test out certain general principles because he is looking to the remote future as well as to the immediate problem; consequently he is more likely to want to introduce the proposed improvements one at a time, letting each operate singly long enough to measure the results and demonstrate whether or not it is really an effective remedy. In other words, he wants to control all the variables and modify them one at a time, in order to be certain of his scientific findings. The psychologist is tenacious of his scientific method, and for this reason asks management to be patient.

2. Psychology asks more discrimination than management engineers have sometimes shown in the selection of psychological collaborators. I have known

more than once a young man or woman whose psychological training was limited to a few months' experience as routine assistant in the Army Psychological Corps or in a social service clinic, or even to a few undergraduate courses in college, to succeed in selling service as psychologist to a business executive. The standing of psychology has sometimes suffered because industrialists have judged results from their observation of the work of such amateurs. If you want a consultant in chemical engineering, would you invest in a young man whose training is limited to undergraduate college laboratory courses, supplemented perhaps by a few months as Sergeant in the chemical warfare service? These neophytes are often extremely useful as assistants, but are rarely competent to take primary responsibility in industrial applications of their science. The American Psychological Association maintains a rigid standard of membership and is open only to those who have earned the Doctor's degree in psychology and have published acceptable research. Membership in the Association is a virtual certificate of fundamental training in the science. Orlando Edgar Miller, who only last October was permitted to give some lectures on applied psychology in this room, is not a member. You can ascertain whether or not an alleged psychologist has met the membership requirements of the Psychological Association by writing to the Secretary, Dr. John E. Anderson, at Yale University.

But membership in the American Psychological Association does not guarantee familiarity with or experience in industrial psychology. The Psychological Corporation, with offices in the Grand Central Terminal, will at any time endeavor to answer inquiries as to the experience of American psychologists in particular fields of specialization. With these sources of information, there is little reason why management engineers should not have a basis for discrimination in the selection of the psychologists with whom they may wish to cooperate.

We ask discrimination also in the acceptance and use of research findings. Sometimes a psychological problem has been solved under laboratory conditions or with a limited number of subjects, so that conclusions of a tentative nature have been warranted; but when these findings have been applied without reservation or further trial under factory or office conditions, the results have been unsatisfactory both to psychology and to management. Generalizations resting on slender foundations should be scrutinized closely and applied with discrimination. I have been warning employment managers for years against hasty use of the results of psychological tests. They should first make careful experiments within their own organizations, with the cooperation of a psychologist who knows statistical method in this field. Only after these try-outs have resulted in a fresh validation of the tests and a determination of the relative weight to be assigned to test scores in comparison with the other available data, should the employing office make any actual use of test results.

In one other regard discrimination is invited. Industrial psychology ought not to be identified exclusively with any single phase or movement such as intelligence tests, or psychoanalysis, or vocational guidance, or mental fatigue studies, or the psychology of practice and skill. Some of these fields of psychological investigation are much less highly developed than others. If you decide that they are vague in practice, or unsound, you will find plenty of competent psychologists to agree with you; but it is hardly discriminating to infer that all psychology is impractical.

3. Psychology asks management for research opportunities. As Dr. Person has so well pointed out,[7] we need opportunity for research on real problems, on adults rather than children and youths, with suitable facilities and assistance, under factory conditions. To be sure, research of this character is more difficult than laboratory investigation. Conditions are more complex. Variables are harder to control. Nevertheless, the time has come when psychology will advance more rapidly if an increasing number of its investigators are occupied on such problems.

4. Psychology asks management to supply one of the indispensable tools of industrial research, namely, reliable criteria. This point has been already urged. Let me illustrate it again from the much discussed field of tests for vocational selection. An enormous amount of ingenuity and toil has been wasted in devising various psychological tests and other predictive measures of aptitude or accomplishment, and in trying out these measures at considerable expense of time and money on large numbers of employees—operatives, clerks, or sales people—only to discover after all the tabulations of results have been made, that the criteria against which the validity of the tests had to be checked were unreliable.

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[7] "Industrial Psychology: A Layman Considers Its Status and Problems," by H. S. Person. *Bulletin of the Taylor Society*, Vol. IX, No. 4, August, 1924, pp. 163-171.

An enumeration of some of the criteria which have been used will show at once how difficult it is to secure from the files of business or industry, data which meet the requirements of scientific work; data reliable enough to serve as checks upon the validity of the proposed methods of prediction.[8] Time required to train an employee is one criterion. Other things remaining equal, the employee who learns his job quickest is the most valuable. Consequently the rate of learning or the time taken by the new employee to reach a standard proficiency has often been used as a criterion of vocational accomplishment. I hardly need remind you how difficult it is to be certain that this figure, the length of time required to train an employee, is a reliable measure of his learning ability, because he may not have had precisely the same opportunities as others for instruction; working conditions may not have been identical with those of other employees; other variables may have complicated the situation.

Grades or standings given by instructors in vestibule schools have been used. This criterion has some reliability when it is based upon actual measures of the skill displayed at the end of a training course. Other criteria which have proved useful are: amount of losses due to breakage or claims; salary or wages; commissions or bonuses; length of service; rate and degree of advancement in the firm; degree of responsibility held; and the like. Often it has been necesary, however, to resort to ratings as measures of success. But ratings given by supervisors, teachers, or fellow-workmen are notoriously and disappointingly variable and unreliable even though the most improved forms of graphic rating scale are used and the rating is conscientiously and painstakingly done. Ratings are less objective than the other criteria which have been mentioned. They should be used as criteria only when absolutely necessary or as a last resort. Perhaps some management engineer will eventually develop a highly reliable rating method, something of which most psychologists at present despair. Any such rating scheme must meet the same statistical test of reliability that other criteria have to meet; namely, the test of high self-correlation.[9] There should also be close agreement between ratings given by several competent judges who are equally acquainted with the men being rated. Such statistically reliable agreement between raters has been found so rarely that ratings ought not to be used as criteria of accomplishment and of worth of the employee to the firm if any more objective, more reliable criteria can be had.

Measures of production furnish one of the most valuable and one of the most frequently used criteria. These measures may be in the form of amount of work each employee turns out per unit of time, or, if one is studying salesmen, the amount sold. Where salesmen are being compared, it is imperative to watch carefully contributory variables such as relative difficulty of the territory assigned to the salesman, extent to which his market has been covered, nature and amount of his competition, time he has been on the job, and other complications. When in 1916 we first began to study at Carnegie Institute of Technology the problem of selecting salesmen, we gave a great deal of thought to the qualities characteristic of successful salesmen, and to test methods designed to measure these qualities. But when in cooperation with several large sales organizations we undertook to test these tests, we found it necessary to go behind the data supplied as to the relative accomplishment or value to the firm of the salesmen tested. We had to scrutinize with the utmost care the methods of market analysis and quota setting these firms had employed.

In using output of factory piece-workers as the criterion of accomplishment, the same caution is needed. To make certain that these records of output or production or piece-rate earnings are genuinely reliable measures of the ability and value of the employees, is a major task of management. Psychology turns with confidence to this group of management engineers and asks that this partciular criterion of accomplishment be made available, and that it be—so far as scientific management can make it—an accurate and reliable measure of the values it purports to measure. Not every manager can furnish such figures of individual output; but in the plant which has long followed consistently the principles of scientific management, it ought to be possible to meet this requirement of psychological research.

What has been said about the need for reliable criteria might be repeated with reference to the control of conditions within the plant. Psychology looks to management to furnish the stable conditions under which scientific experiments can best be conducted; plants with adequate records of their personnel;

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[8] "Measurement in Vocational Selection,—An Outline of Research Procedure," by Max Freyd, *Journal of Personnel Research*, Vol. II, No. 6, October, 1922, pages 220 to 224.

[9] E. L. Thorndike, "Mental and Social Measurements." Teachers College, Columbia University, New York, 1913, page 177.

plants where measures of accomplishment of workers and executives are available as criteria for judging the effects of psychological factors; plants whose excellent management eliminates many of the disturbing variables from problems that are at best almost bafflingly complex.

What psychologists ask for then in their cooperation with industrial engineers is the scientific attitude; an attitude that is patient with the limitations of a young science; that is sympathetic with a point of view that has as a first objective the discovery of new truths about human nature and the use of these truths to increase man's well-being and satisfactions in work; that is discriminating and open-minded when research findings are offered for industrial consumption; a scientific attitude, moreover, which has permeated the control of the organization and borne fruit in management which is truly scientific.

Annual Business Meeting

THE 1924 business meeting of the Taylor Society was held in connection with a member's dinner at the Fraternity Club, New York, Thursday evening, December 4, following a meeting of the Board of Directors at the City Club at noon.

The reports of the Managing Director and of the Treasurer (who was unfortunately absent in the west) were presented by Mr. Person. R. A. Feiss, President of the Society for the past three years, presided and presented a statement of the history of the Society, its present problem and future outlook, and then called for the results of the official letter ballot for the election of officers.

S. E. Goltra, Chairman of the Committee of Tellers, reported balloting as follows:

President (1 year)—	Percy S. Brown	287
	Scattering	5
Vice-President—	Howard Coonley (1 year)	285
	Henry P. Kendall (2 years)	287
	Scattering	6
Treasurer (1 year)—	Edward W. Clark, 3d	290
	Scattering	1
For Board of Directors— (2 years)	Nathaniel G. Burleigh	288
	C. Leslie Barnum	286
	Scattering	10

Advisory Committee—in favor of the establishment of an Advisory Committee (available for consultation to directors and executive officers) whose membership shall consist of former presidents of the Society.

Yes	244
No	17
No vote	32

In taking the chair, Mr. Brown replied to Mr. Feiss's statement, speaking particularly to "plans, hopes and aspirations for the future." He then called upon Howard Coonley, Mary Van Kleeck and Henry S. Dennison, who spoke on the present problems of management, and the contribution of the Taylor Society—as Miss Van Kleeck put it, "the process leading to answers to these problems in the kind of philosophy of this group." (See page 242.)

After informal talks by Irving Fisher (printed elsewhere in this issue), Robert B. Wolf, George D. Babcock and Robert T. Kent, the meeting concerned itself with problems of membership promotion. The following motion of the Board of Directors was approved:

VOTED: that the Board of Directors be and hereby is instructed and authorized to consider the problem of revision of membership classification and of dues, and, if in their judgment it is desirable, to formulate a new schedule of classification of membership and of dues for submission to the membership as amendments to the constitution in accordance with the procedure established by Article 29 of the Constitution.

The last order of regular business was the election of the following to serve as a nominating committee for the coming year: Robert T. Kent, Albany, N. Y.; Stuart Cowan, New York City; Edgar D. Sebring, Groton, N. Y.; Warren D. Bruner, Chicago, Ill.; and Louise Odencrantz, New York City.

The Basis of Industrial Psychology[1]

The Psychology of the Total Situation Is Basic to a Psychology of Management

By ELTON MAYO

Research Associate, Wharton School, University of Pennsylvania[2]

I. Methods of Psychological Inquiry

IN AN address delivered before this Society in April,[3] Dr. H. S. Person examined the existing relationship of psychology and industry. He pointed to the need of a closer relation between the two. He showed not only that industry stands in need of expert psychological investigation but also that the present defects of psychology are largely traceable to the absence of facilities for investigation of the adult mind as it manifests itself in its daily activities. Dr. Person listed four types of psychological methods and their attendant theories. He pointed out the ways in which these approaches had aided or might aid industry. But he also evidently felt that they individually and collectively left something to be desired, for he concluded, "If life be an integral whole, if the behavior of men in industrial relations be in any considerable degree the result of stimuli received elsewhere than in office and factory, then industrial psychology must have for us a new and larger meaning."

It is the purpose of the present paper to show that Dr. Person's criticism is fundamental not only for industrial psychology but for general psychology as well. It is true that life is an integral whole, and that the worker in the plant and the citizen in the home are essentially the same individual. The actions of any such individual in plant or home cannot be understood as things in themselves; they are incidents to be studied and interpreted as parts of an individuality that is the subject of a continually developing awareness of surrounding. The only adequate basis for psychology, either in industry or elsewhere, is one that will admit this as its essential fact and will work out the implications of this admission in all fields. Such a study we may refer to as a *psychology of total situation.*

Let me explain what this means more concretely by reference to a single simple instance. A worker was sent to us for observation and inquiry because he was suffering disabilities with respect to his work that he was unable to explain. He was highly regarded by the management, his domestic situation was satisfactory, and the conditions of his work had recently been bettered. We found that for four years it had been his habit, as he worked, to reflect upon his more unpleasant experiences when in the fighting line in France. Being a person of average normality, he was able to give up this type of thinking when its dangerous consequences were indicated. And his capacity for happiness and work showed an immediate and remarkable improvement. Now my point is that no investigation of his concentrated thinking would have revealed the situation. He did not concentrate upon these topics at any time; he rather avoided doing so. Nor would any investigation of his adaptation to his job or of his general intelligence have given the correct clue. A psychiatric clinic would probably have discovered what was wrong, but he was not likely ever to have become sufficiently emotional to have been sent to a psychiatrist. This sort of situation is constantly arising in every department of human relations and is not effectively dealt with because there is at present no psychological technique which takes account of the individual's total attitude to life and work. Various methods take account of various aspects of the individual's mentality as if they were things in themselves, and the result is that there is no psychological criterion by which the respective importance of various facts revealed can be adequately assessed. In the case specified above, the worker concerned was adjudged normal by factory and dispensary alike.

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[1] Paper presented at a meeting of the Taylor Society, New York, December 5, 1924.

[2] Formerly Professor of Psychology in the University of Queensland. Spent a number of years as lecturer and research scholar, Universities of Adelaide and Queensland. From 1916-23 did research work in psychopathology, civilian and military, which resulted in the founding in the University of Queensland of a special research chair in Medical Psychology. Had leading part in establishing psychopathological research in Australia. Author, "Democracy and Freedom"; "Australia—Social and Political Essays"; "Psychology and Religion."

[3] *Bulletin of the Taylor Society,* Vol. IX, No. 4, August, 1924.

Of the various methods at present employed, one may specify three in order to show that they are unsatisfactory in the last resort. One psychology examines the inner articulation of concentrated thinking and makes small effort to discover why an individual should concentrate in this or that direction, or how it is he achieves the mental tension necessary. Another psychology examines the inner articulation of obsessions in a somewhat similar manner. The third type concerns itself with industrial production and limits its inquiry to those aspects of productive activity it considers to be relevant to its problem. All three fail because they have no investigation of total situation to assess and direct their inquiries. They cannot even correlate the different methods they employ.

Directly one takes account of the individual's total situation, a very different result follows. One finds that lesser differences of method are superseded—the one technique is capable of an infinite diversity of applications in factory, school and clinic. In a large factory in the Middle West my attention was recently called to certain interesting illustrations of this fact. Three women worked side by side at a bench; the productive capacity of two suddenly diminished remarkably, the capacity of the third improved. Inquiry showed that the third had recently been very happily married. Of the two whose efficiency diminished, one had had her son arrested by the police for failing to support his family, the other was in process of divorcing her husband. Productive efficiency, like capacity for concentration, is a product or expression of a total mental situation. No mere investigation of productive method or intelligence is enough. In the same factory many other illustrations offered. One girl was in the habit of lying down during the rest periods; her efficiency was much above the average. Certain girl workers were under weight and were put upon a regime which included a fifteen minute period of rest upon a couch in the morning and afternoon. Their productive capacity was greatly increased. Generally it may be said that no psychological method which fails to take account of total situation can hope to be satisfactory either to industry or to psychology itself. What is wanted is a coordinated study of human nature and human behavior capable of being applied in any field.

The question as to what this technique or method should be presents, on the first glance, considerable difficulties. Dr. Person, like the late Dr. Stanley Hall in his last published book, is forced to face the fact that we apparently have not one psychology but many psychologies, not one technique but a diversity of techniques with no obvious common basis. At the very outset of the inquiry, one is compelled to ask the status of these various investigations and especially to ask the nature of the human facts at which each investigation is pointed. Discovery of the relation between the various areas of fact investigated is the only means of discovering the relation between the various methods of inquiry.

There are at present two general forms of psychology in the field—the academic and the medical. I do not propose in this paper to give any special attention to behaviorism in the strict sense, first, because it is an outgrowth of the academic psychology and, second, because it still bears the marks of its physiological origin. In thus discarding it as irrelevant to my present purpose, I must not be supposed to be hostile to or doubtful of the value of physiological investigation. Physiology is at least as important as psychology in the understanding of man; but behaviorism is as yet a physiological rather than a psychological development. At any rate, insofar as behaviorism is psychological, the general outline of my discussion will apply.

II. The Academic Psychology

The academic psychology has been developed mainly in universities, the medical mainly in psychopathological clinics and hospitals. In respect of logic and scientific method, the advantage rests with the academic; in respect of the area of fact surveyed, the advantage rests with the medical. There has been a certain carelessness in the use of words in the clinic; phrases have been admitted to common use which may have a definite reference in case work, but possess no precise logical meaning. On the other hand, the need of dealing with individual situations has forced the clinic to take account of factors which the laboratory can discard. The hope of an adequate psychology must be conceived as dependent on the extension of logical method to cover the whole area of relevant human fact.

The undue restriction of the academic investigation is consequent upon, first, the so-called sensationist tradition in psychology and, second, that limitation of opportunity so well described by Dr. Person. The former of these I cannot do more than mention in this place. The latter is a fact that is becoming increasingly evident and calls for alteration. At no time have clinics and factories been freely open to psychological observation and research. To this alone is due the fact that the demand of the present for expert assistance remains unsatisfied. It is not possible to reproduce in the laboratory normal conditions of human life and work. This the English investigators of industrial "fatigue" have discovered.[4] It was possible to reproduce in a darkened laboratory room the physical surroundings of the coal miner, but it was not possible to reproduce under such artificially contrived conditions an identical mental attitude. By reason of his tradition and his limited opportunity, the laboratory psychologist has tended to take account only of what we may describe as concentrated thinking; his theory implies that concentration is the only form of mental process in which psychology is officially interested. Laboratory experiments have usually demanded not merely concentration but special efforts of concentration; this applies equally to psychological tests and to inquiries such as that of Kraepelin into the nature of mental fatigue. I must not be supposed to deny the high value which such researches undoubtedly possess; my claim is rather that this alone is not enough. That the waking life of the individual is not wholly given to concentrated thinking is admitted by every psychologist of note. There is need that psychology should study dispersed thinking or revery and sleep. Every psychopathological investigation of the past fifty years has tended to the conclusion that the major decisions of a lifetime are made in mental moods of relaxation rather than tensity.

But limited opportunity and laboratory procedure have had another consequence for academic theory. Pierre Janet[5] has shown that capacity for mental tension or concentration consists not merely of a facilitation of the dominant thought process but also of an inhibition of other responses to the existing situation. Capacity to think about the subject of this lecture, for instance, involves not merely a consent and an effort to listen; it involves also a refusal to listen to noises in the street outside, a refusal to reflect upon the nature of the audience, one's personal comfort or discomfort and matters equally irrelevant. Yet one is as conscious of these other things as of the topic of the lecture; the difference is that one refuses to think about them. This distinction between the larger object one is conscious of and the lesser object one is thinking about is unduly neglected by psychology. Description of "mental process" in terms of concentrated attention has led too many psychologists to disregard the wider hinterland of awareness which surrounds, as it were, the dominant thought activity of any given moment. The fact is of course admitted, but its importance as determining the nature of and capacity for concentration has apparently been realized by Janet alone. C. Lloyd Morgan[6] and G. F. Stout[7] mention this wider awareness, then describe it as "subconscious" and take no further account of it. Bosanquet[8] comes much nearer to the truth. He begins by pointing out that the "presentations at the focus" of consciousness are "probably the smallest part of what the mind has present to it." His criticism of sensationism is that sensationist theory takes account only of "the focus" of consciousness—that is to say, of the object of immediate concentration. Yet in spite of this claim, he proceeds to follow the same road as Stout and Lloyd Morgan and fails utterly to develop his assertion that the course followed by any concentrated thought is largely determined by "presentations which are not in focus." He also falls into the trap which the word subconscious prepares for the unwary psychologist.

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[4] "Fourth Annual Report," Industrial Fatigue Research Board, 1923.

[5] "Les Névroses," E. Flammarion, Paris, 1909, 1917, pp. 346-367.

[6] "Introduction to Comparative Psychology," W. Scott, Ltd., London, 1894; Scribner's, N. Y.

[7] "Manual of Psychology," University Correspondence College Press, London, 1899; Hinds and Noble, New York.

[8] "Psychology of the Moral Self," Macmillan.

It may seem at this point that I am deliberately involving myself in unnecessary technicality. I should like to assure my audience that this is not so; my object is to show that laboratory procedure has permitted the academic psychologist to disregard an important fact which hospital practice has made the central thesis and research of medical psychology. One more illustration and I shall have completed this part of my discussion. E. B. Titchener[9] some years ago called attention to the excessive abstractness and consequent falsity of psychological descriptions of consciousness. He was at some trouble, indeed, to name a number of the lesser awarenesses which accompany and coexist with any act of concentration. He would probably have succeeded in re-stating psychological theory but for the fact that he conceived consciousness as a multiplicity of processes rather than a single total awareness. His doctrine is that the consciousness of any given moment consists of a sum of simultaneous processes which run their course in time together. This unwarranted equalization of the various parts of the conscious field involves him in confusion. The dominant thought of any moment is a process, a development of experience and knowledge; the surrounding awareness involves no learning—it is not process in the same sense. In spite of his clearer vision, Titchener is forced by his conception of mental process as the fundamental fact of psychology to attach a superior reality to concentrated thinking. He tries to describe a marginal and inhibited awareness as though it were facilitated; and he fails consequently to see that the fundamental fact for psychology is not mental process but a wide awareness of which the dominant process is a product or expression. He still retains the species of double vision to which his doctrine leads. In a recently republished book[10] he maintains that psychology is the study of mental processes, that mental processes do not intrinsically mean anything and[11] that "meaning is always context." This assertion of what is almost the truth becomes especially interesting when compared with the method and theory of medical psychology.

Generally, it may be said of the academic psychology that, by reason of its tradition and restricted laboratory procedure, it has tended to neglect unduly moods of mental relaxation, to regard concentrated thinking as the only fact for psychological investigation and to disregard the wider awareness, or total situation, of which concentration is at all times the expression or product. The method of medical psychology, imposed upon it by hospital practice, is directly contrary.

III. The Medical Psychology

The two aspects of the medical psychology which I wish particularly to call to your attention are, first, the direction of the inquiry, and second, the method it employs. The direction of the inquiry is especially illuminating in view of what I have said in criticism of the conventional academic method. When a patient is brought into a clinic his thinking is obsessional in character and of value mainly as a symptom. Considered as a dominant thought process after the academic fashion it is chiefly remarkable for its utter irrelevance to reality. Yet it is as unmistakably "there" as any reasoned idea in the normal. Certain instances occur to me in illustration. A girl of 25 was much troubled by the idea that she was "going mad." Two men of my acquaintance "wanted another war." I knew one in a Queensland military hospital, the other in a Philadelphia factory. Both had arrived at this obsession by the same road—long meditations in moods of mental relaxation upon the more ghastly experiences of the war. A professional man took to his bed and refused to get up fearing that he might be "hit by a meteorite." Another professionally trained man constantly expected "an explosion," and was not clear as to whether he or his surrounding was about to explode. All these individuals were in a sense rational; that is to say, they were perfectly well aware of the absurdity and irrationality of the obsessing idea; their complaint was that they were unable to escape thinking it. Now all the various schools of psychopathological investigation proceed on the assumption that these obsessions are the product of long trains of dispersed rather than concentrated thought, originating usually in infancy. An unsuitable environment in infancy has bred an attitude that has persisted into adulthood, long after the infantile surrounding has ceased to be. The obsession can indeed be understood as an adequate response to reality once one knows the patient's intimate history and total attitude to life. Four of the five cases specified above recovered their mental normality comparatively quickly, once their total situation was systematically investigated. This statement of the direction of the inquiry explains the essentials of the method.

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[9] "Outline of Psychology"; Macmillan, 2d edition (1901), pp. 9-11.

[10] "Beginner's Psychology," Macmillan, 1915, 1922, pp. 26 ff.

[11] P. 118.

The methods—and they are many—employed by psychopathologists are all variants of Pierre Janet's "method of distraction." The methods best known are hypnosis, the hypnoid investigation of Sidis, Jung's association test and Freud's dream interpretation by free association. One might add to the list crystal gazing and automatic writing. All these methods are variants of the methods of distraction, because they involve a looking away from the dominant or obsessing idea towards the total situation which has produced it. The early history of the patient, the incidents of his upbringing and education, his adaptation to his surroundings, his dominant trends of revery or day dream in moods of mental relaxation—these items are found to bear an important relation to his total attitude to life at any present time. As compared with the academic, the medical psychology is less logical in method but it has opened up for survey and consideration a much wider area of facts directly relevant to successful thinking and living. In particular, it has drawn attention to, first, the technique of thinking, and second, the content of thinking as affected by the individual's total situation. The chief representative of the former inquiry is Pierre Janet. Janet, working with Charcot, succeeded in demonstrating that the difference between normality and abnormality, rationality and irrationality, may be described as a difference of relation between concentration and dispersed thinking or revery. In the normal person revery illuminates concentration, concentration supplies the material of observation and brings the inspiration of revery to the test of empirical fact In the abnormal person, concentration and revery are pointed in different directions; the result is that mental condition which is described as divided or alternating personality. In all such cases, there are two or more total situations in the one individual, both defective but each with its distinctive attitude and memory.[12]

The chief representative of the inquiry into the content of thinking is Freud. In the early stages of his investigation, Freud found difficulties with hypnosis and was accordingly led to substitute for it an inquiry into the content of the psychoneurotic mind. He has held at various times three different theories, only one of which, the sex theory, is apparently generally known. The essential of the Freudian discovery is the irrelevance of the syntheses which constitute primitive knowledge. The child, the savage and the neurotic do not explicitly criticize the meanings they derive from experience. A soldier suffers cerebro-spinal meningitis and recovers. Subsequently he hears gossip to the effect that a local paralysis will surely follow. After three years of "submerged" meditation upon this, he develops a hysterical inability to use his left hand and forearm. Instances can be multiplied indefinitely; the magical procedures of savage tribes are as excellent an illustration as any psychoneurotic history. The primitive mind has no logical criterion available by means of which it may sift the reasoned from the unreasoned in its thinking. An African tribesman breaks a piece off an anchor washed up on the beach; subsequently he dies. For generations the anchor becomes a fetish for his tribe.[13] "Irrelevant synthesis" is the chief character of primitive thinking.

The effect of this upon the individual's attitude to life is that all kinds of irrelevant and unjustified meanings are dominant in his total situation. His own capacity to analyze and reconsider is small because he has, for the most part, forgotten the events from which the defective ideas were derived. But there need be no mystery with respect to "hysterical amnesia"; whether normal or abnormal, we all tend to forget events and to retain their meaning. A mathematician demonstrating the binomial theorem would be puzzled to describe the events in which his mathematical knowledge began. As we come to understand, we re-interpret the world about us in the light of our new knowledge. It is the world, or rather our total situation, which carries meaning for us. The events which gave us the meaning are forgotten. For a normal person the world has no terrors; for a hysteric, the world is full of terrors which justify his fearful attitude and behavior. Primitive and neurotic meanings are based upon experiences uncritically interpreted; the psychopathologist seeks to revive and to re-interpret the experiences from which such meanings have been derived.

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[12] "Les Névroses," pp. 39, 345, 367.

[13] Haddon, "Magic and Fetishism," Open Court Publishing Co., Detroit, 1908, p. 85.

IV. Conclusions from the Medical Investigation

It is unfortunate that a clumsy and unnecessary terminology should have collected about the researches of the psychopathologist. Terms such as subconscious, unconscious, foreconscious, co-conscious do little but cause confusion and take attention away from the really important aspects of the investigation. If we put all this on one side and look at the facts elicited by clinical research we find:

1. That it calls attention to the existence of four mental states—concentration, dispersed attention or revery, hypnoid states and sleep.
2. That it shows the importance of dispersed thinking in education and in all determination of personal attitudes.
3. That it demonstrates total situation to be the fundamental fact for psychological study.

1. Until quite recently, it was customarily assumed that during the 24 hours of the day, an individual is either awake and conscious or asleep and unconscious. It is now possible to distinguish the four general mental states specified above. The point of chief interest, however, is not that four states are distinguished in place of two; it is rather that the distinction must be stated in terms of attention and inattention. All four are states of consciousness; even sleep must be described as inattentive consciousness. Concentration is the state of greatest mental tensity, sleep is the condition of greatest relaxation. But a passive awareness of the surrounding persists in sleep. This is illustrated by the fact that it is not the intensity of a stimulus—for example a sound—that wakes a sleeper but rather its meaning for him. In the maternity hospital the loud clang and crash of the trolley car outside does not wake the mother, but at the slightest stir in the cot by her side, she sits up in bed. A "shell-shocked" soldier was afraid of the dark but slept well at night if the lights were left on. Directly the lights were turned out, he wakened. Telegraph operators in the country districts of Pennsylvania are allowed to sleep on night duty. They all hear the call for every station, but all alike develop a capacity for waking immediately when their station is called and for sleeping through other signals. Illustrative facts could be multiplied indefinitely. The whole study of what is usually termed suggestion is a study of the passive responses of dispersed thinking, hypnoid states and sleep.

2. The importance of dispersed thinking is chiefly that described by Janet. The direct relevance of this French psychopathology to factory investigation is astonishing. Janet speaks of neurotic agitation as due to crises of revery; he also points out the difficulty of maintaining mental tensity or concentration, and consequent temporary disintegration, when fatigue has set in.[14] With respect to mental normality as implying a cooperative relation between concentration and revery, it may be said that the same fact is observable in the factory and in business generally. Those whose reveries are relevant to their work are the successful men; the reveries of the unsuccessful men seem to be irrelevant to what they are doing for the most part. This is not, of course, their fault nor are they in any sense to blame.

3. Total situation is the fundamental fact for psychology. Medical researches into the nature of sleep and dispersed thinking give us a new conception of the mental life of man. We have to distinguish between that conscious awareness of, or orientation to, our surroundings which is a steadily persistent character of our mental life, and the act of attention to some particular thing—an active "thinking about" things which is only fitfully present. The conscious awareness of surrounding which begins with infancy persists practically uninterrupted through sleep and waking until the hour of death. Its general character changes slowly as successive experiences or acts of attention establish new meanings or new individual attitudes. But at every point or moment its general character determines the type and quality of the attention or thought that can be given to any aspect of the surrounding. There need be no difficulty with this conception; the same truth holds, for example, of our muscular apparatus. One who has been athletic in youth has established a working relation between his "contractile" muscular fibres which adapt a limb to a new position and his "plastic" muscular fibres which hold that posi-

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[14] "Les Névroses," p. 358.

tion. Long after he has given up games this relation between muscular contractility and plasticity persists and shows itself in every least or trivial movement. So with our mental attitude; the general significance of the world, determined by earlier thought and education, informs and fixes later capacity for thinking. For every individual the world is primarily meaning derived from former thought and experience. This meaning forms the background against which the particular events of the day, week and year are displayed; it varies with the individual and is perpetually present in his mental attitudes. This is the significance of total situation; we cannot understand why an individual suffers an obsession or leaves his job or, it may be, thinks logically, until we know the background against which for him the events of life are played.

And in considering this it is important to realize that this total attitude is not by any means the product only of concentration or logical thinking. In the average instance, revery—and most frequently revery of an irrational type — has done even more to determine attitude than concentrated thinking. In the total situation of the average individual consequently, both rationality and irrationality play a part. A steady period of work may be succeeded or interrupted by an unexplained flare of emotion, astonishing even to the individual himself. No psychological method can hope to contribute anything to the understanding of incidents of this kind, or to the general understanding of individual attitudes, unless it takes account of total situation. Methods which look only at concentrated thinking or at adaptation to work or at obsessive thinking as if these were facts in themselves, are in the position of an engineer who looks at the apex of a pyramid and neglects to examine its base. The apex is supported by its base; every act of concentration is the product or expression of a total mental situation.

Pierre Janet's point is well taken; capacity for concentration, or the explicit perception of realities, or work, is to be understood as capacity for mental tension. Whenever the total attitude is ill-organized or unduly compounded of the irrational products of irrelevant revery, then concentration is difficult or impossible to achieve. And since it is by concentration that we achieve an explicit hold upon the reality about us, it follows that in all such cases the hold upon reality is tenuous in the extreme. Any condition of living which makes for too much revery thinking of an irrelevant type tends to diminish the individual's hold upon reality. Concentration is possible only when supported by a well-ordered total situation. It is the business of total situation psychology in industry to investigate and to eliminate conditions which lead to disharmony in the individual's mental background, and to promote that orientation which alone makes reasoned adjustment to the job possible. Disturbances may originate either in the personal history of the individual or in the present conditions of his work or both at once.

V. The Approach to the Factory

I am well aware that at this point many members of my audience will be asking, perhaps with some alarm, what I propose to do—whether industry is to be asked to submit its entire personnel to the ministrations of the psycho-pathologist. I can at once reassure those who have such questions in mind. There are at present, in every economic organization of any size, personnel managers and psychologists whose business it is to handle the human problems of industry. My whole claim is that such experts should be trained in the type of psychology I have briefly described. The responses of every individual to the associations and opportunities of the factory or office are, for the most part, determined by causes in his personal history and total situation which lie beyond the immediate control of the management. If the personnel manager or industrial psychologist be trained to take account of his total situation in dealing with an individual, it will involve no more work than at present and the work will be infinitely more effective. There are in particular two reasons why training of this type is becoming increasingly necessary to successful management. The first is that modern methods of industrial organization tend to impose on the average individual long periods of revery thinking. Machine operation, once the worker is habituated to it, does not demand a high degree of concentrated thought. On the other hand, it is impossible for him to concentrate his mind upon anything else. One finds in actual practice, therefore, that the mental mood which accompanies work is very frequently a low-grade revery of a pessimistic order. In one instance we discovered a worker who, during part at least of his working day, fell into the hypnotic somnambulic condition. Now the danger of this general condition of things both to the individual worker and to industry is obvious to anyone acquainted with psychopathological work. All the authorities agree that an adult nervous breakdown originates in earlier pessimistic reveries—one authority indeed specifies feminine handwork as offering much opportunity for the development of a hysterical mentality. Insofar as this general state of affairs exists and remains uncontrolled, we may expect an increasing condition of emotional unrest manifesting itself in the periodic "crises of revery" so well described by Janet.

The second reason why psychological investigation is necessary to industry is that these pessimistic reveries which culminate in disorder and unrest (absenteeism, high labor turnover, strikes) are relatively easily controlled provided that the management has a means of discovering the nature of the cause. It is in respect of this control that the factory differs from the hospital and clinic. A psychoneurotic is little benefited by a change of his conditions of living or working; the relatively normal worker in a factory responds at once to any betterment of his total situation. An individual's occupation is at least half his life; if his occupation is interesting and stimulating, he can support a burden of domestic and private difficulties which would otherwise tend to depress or break him down. Our inquiries seem to show that the usual form which pessimistic revery takes in the factory is that of depressed reflection upon personal and intimate affairs. It is important for management to realize that the conditions of work or occupation can exaggerate or minimize this tendency.

In passing, I should like to call attention to the fact that in discussing these two reasons I have been discussing the vexing question of monotony and boredom as distinguished from physiological fatigue. Monotony in itself is apparently a matter of no great moment; the definition of what constitues monotony will, in fact, be found to vary with every individual. Monotony becomes a problem for the management of a concern only when it is obviously giving rise to pessimistic revery, not merely in individuals but over wide areas of the personnel.

The psychological approach to the factory, defined as I have defined it, does not involve at the outset any elaborate confusions of card indexing or numerous additions to the office staff. It takes existing problems and re-states them in terms of total situation in individuals and in the factory itself. Its object is better understanding, improved control, and an increase of human happiness.

VI. A Case in Point

I can best explain by an illustration, after which I shall have done. Rather more than a year ago the Industrial Research Department of the University of Pennsylvania was asked to make what contribution it could to the solution of certain problems in a textile mill. The problems, briefly stated, were:

1. A high labor turnover and low productivity in a spinning department;
2. Absenteeism and "eye-strain" in a sorting department;
3. Low productivity in a pickering department;
4. Absenteeism in a winding department.

The only investigation actually proposed to us was that of the high labor turnover in the spinning department; the other problems were discovered as we worked.

1. The spinning-mule investigation has been reported and discussed at length elsewhere,[15] and I do not propose to renew the discussion here. Our findings, briefly stated, were that the conditions of work involved a considerable degree of postural fatigue. This fatigue was complicated and increased by an almost universal incidence of pessimistic revery. To remedy this, the management introduced rest-pauses, four in a ten-hour day, in which the men were asked to lie down and were instructed in the best method of relaxation. Since the institution of this system the labor turnover has become negligible, the evidences of general pessimism have diminished or disappeared, and the productivity of the department has increased by approximately 15 per cent.

2. The sorting of white wool and cotton was done entirely by women of varying ages. There was a tradition in the department that the work caused eye-strain and indigestion. This tradition appeared in the reveries of the workers as an expectation of these ills; every worker in the department gave evidence of such expectation. In

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[15] *Journal of Personnel Research,* Vol. III, No. 8, December, 1924.

this and other departmental investigations, we have had the most excellent backing and collaboration from the Graduate Medical School of the University. Care of the physical welfare of the individual being thus assured, we tried the experiment of interrupting the sorting by six ten-minute rest-periods in a ten-hour day. In this instance, as with the spinners, workers were given individual instruction in the best methods of rest. The effect has been to eliminate altogether the periodic emotional crises which used to characterize the work of the department. There have been no complaints of eye-strain or indigestion for six months; absenteeism and evidences of pessimistic thinking have disappeared. There is in this instance no means of measuring productive output, but the management is entirely satisfied that there has been no diminution.

3. The situation in the pickering department has at no time been made the object of active investigation. The management some months ago adapted the procedure in the spinning department to the picker house. Since that time those employed in pickering have earned bonuses of from 5 to 14 per cent. Previously, they had earned no bonuses.

4. The winding department is interesting chiefly because it illustrates a variation of method. Cone-winding is piece-work, and supply is sometimes irregular; workers are therefore unwilling to take regular rest-periods. The workers are women and the relatively high rate of absenteeism was found to be largely due to a tradition of incapacitation by menstrual "cramps." In one month, for instance, one-half the departmental strength absented itself for a day or more for this reason. In this instance, as with the sorters, it was discovered that the tradition of the department appeared as a revery of expectation in the individual. The work involves postural fatigue, the reveries tend to be pessimistic, and the occasional recurrence of the tradition in such reflections acts as what used to be called a suggestion. Investigation was made medically and also by the dispensary nurse. It seemed entirely possible that physical fatigue might contribute to the causation of dysmenorrhoea. We were somewhat astonished to discover that the physical causes are apparently negligible as compared with the mental. I am expertly informed that the medical help given is not more than "an aid to suggestion"; but the individual attack upon the revery and traditional expectation by the nurse in charge has had the effect of almost entirely removing this cause of absenteeism. In one period of four months, for example, there was no time lost by reason of this ill.

VII. Total Situation and the Individual

This paper would not be complete without some reference, however brief, to our method of approaching the individual and to the content of the pessimistic reveries in particular cases. The individual has to be approached with care, but once he understands that his happiness and well-being are our concern, and that confidences are not divulged to his fellows or the management, he is usually willing to help the investigation. Given this collaboration, our endeavor is to discover:

1. His physical condition and medical history;
2. His personal history, including his dominant reveries;
3. His domestic situation;
4. His adaptation to his work.

This investigation of individual situations is more interesting than the inquiry into general or departmental situations. It will in the end probably yield more in the way of definite knowledge as to what is happening in industry and in the detail of civilized life. In by far the greater number of cases there is some unsatisfactory circumstance, usually of personal history or private life, which is a habitual topic of dispersed thinking or revery. Any monotony of occupation or unpleasantness in work tends to extend and emphasize this thinking. We have under investigation several hundred individuals of average normality and I give one or two instances which must not be supposed to be specially selected; they are taken more or less at random and are typical.

A girl of twenty-seven has been engaged upon a machine operation for nine years. She began work in adolescence to support her mother and four brothers and sisters after the father's unexpected death. For five years she was the sole support of the family; in the last four years a brother has helped. For seven years she was the best worker in the department; latterly her production has been less. Two years ago a young man wished to marry her and she had, so she says, a nervous breakdown. She is much opposed to marriage; she has developed in revery an expectation that if she marries her adolescent experience may be repeated and a young family require her sole support. Many discussions gave her an opportunity for expressing her reveries for the first time and her production has recently improved. She is still opposed to marriage.

A clerk in charge of deliveries, approximately twenty-eight, occasionally absents himself from the factory and stays in bed for a day or two. After the war he was unable to work for two years; he suffered what he describes as "neurasthenia." He is happily married and has four children. He is highly esteemed as a worker by the management and as a man by his fellow-workers. He contributes cartoons and humorous columns occasionally to publications and earns small sums thus. He suffers financial anxieties on his children's account. He habitually indulged in anxious or gloomy reflection as he worked until the unwisdom of this practice was pointed out to him. Since then his health and outlook have much improved. He has more intelligence and ability than his work demands; he cannot easily find a quiet corner in his home. His periods in bed are crises of revery; they are diminishing in frequency as he learns how to control revery. He should have more interesting work.

A machine operative of thirty-six is married to a woman much older than himself. They have no children and both regret it. He is highly skilled and is valued by the management. He complains of "neuritis" in his back which his medical attendant cannot diagnose. His wife has spinal curvature.

A man of thirty, married and with several children, is engaged upon a monotonous and unpleasant job. He suffers occasional emotional crises in which he is afflicted with panic for no very obvious reason. These crises were difficult to handle until it was discovered that at the suggestion of rest he would drop into a condition of hypnotic somnambulism. Inquiry shows that his work has played some part in developing this capacity in him.

A girl in the early twenties is engaged upon a monotonous machine operation for ten hours daily. She partly supports her mother and a large family. The father lives with them but has been demented for some years. A certain proportion of her work time is given to speculation upon the possibility of a similar development in herself.

When individual situations are thus described, I have no doubt that they have an air of being specially selected and unusual. The point I wish to make is that these are fair average samples taken from the several hundred cases we have under investigation. It is only rarely that we discover an individual entirely free from irrational or pessimistic or irrelevant revery thinking. There is of course an immense difference according to the suitability or unsuitability to him personally of the work upon which he is engaged. If the conditions of work are good or the work interesting, then his job acts as a corrective of any tendency to pessimism or as an antidote to any actual difficulties or problems. On the other hand whenever pessimistic reflection emerges, the effect upon productive efficiency is striking and immediate. This I have illustrated not only by cases taken from Philadelphia but also by those instances of workers in the Middle West cited in my opening paragraphs. Productive capacity, like capacity for concentration, is symptomatic merely of the total situation of the individual. When the total situation is adversely affected by any cause whether within or without the factory, a diminished capacity for work will always be one among other symptoms.

It is easy, therefore, to exaggerate the effects upon the individual of a traditional discontent within a factory or of so-called "agitation." It is altogether probable that such traditional expressions of emotional attitude have no effect upon individuals except when they afford a means of expressing individual discontents. Our experience with such traditions of discontent has been that the actual individual situation is different in every case; the traditional complaint is no more than a common vehicle of expression.

This type of investigation is not unknown in the United States. The need for it was expressed by Simon Patten of the University of Pennsylvania. The form it should take was explicitly stated by the late Dr. E. E. Southard of the Boston Psychopathic Hospital. In a sense, the work involves an extension of that begun by the pioneer by whose name this Society is honored. Taylor confined his attention, upon the whole, to the problem of irrelevant synthesis or mistaken coordination in our muscular apparatus; there is urgent need to extend this inquiry to discover what irrelevant syntheses of emotions and ideas are imposed upon workers by indifferent education and unsuitable conditions of work. I use the term "workers" here to include proprietors and managers as well as machine operatives. Over the whole field of industry dispersed thinking and emotions bred of revery are making for unrest and breakdown rather than content. Many investigators are needed, but since few opportunities have been offered to the Universities, the inquiry is slow to begin. Industrial psychology is but one aspect of a research into the nature of man. Without such research civilization cannot endure.

The Achievements of Motion Psychology[1]

By Frank B. and Lillian M. Gilbreth

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IT IS now almost thirteen years since the importance of this relationship of psychology to management was stressed before those interested in scientific management, at the Dartmouth Conference.[2] For seven years before that time, steady progress had been made in correlating psychology and management, but from that time on the correlation was placed upon a scientific basis. As an account of the "state of the art" of applying psychology to management, Dr. Person's paper on industrial psychology[3] is both timely and interesting.

We agree with Dr. Person as to the need to recognize the limitations and to estimate the achievement of psychologists, especially in the field of industry; the need to recognize that they cannot at once, even though afforded all possible opportunities, solve all pressing industrial problems, and the necessity for the manager in industry to prepare opportunities for psychologists, to offer facilities for their investigations and to cooperate in every possible way. We agree also as to the problems that might profitably be considered;—but before future developments in industrial psychology can be profitably considered, it is necessary to estimate past and present conditions adequately.

In attempting to present in a few words the progress which has actually taken place in correlating psychology and management during the past twenty years, it is necessary to note that while the first step was to compare and harmonize the vocabulary and methods of management and psychology, from the start psychology has been defined, both by the psychologists and managers interested, as the science of behavior, or the science of motions. Behavior psychology, or motion psychology, has resulted.

In finding and teaching The One Best Way to Do Work, we prefer to use the phrase Motion Psychology for two reasons:

1. Every mental process has outward visible and recordable motions.

2. Every opportunity should be used to get the entire organization to think of all management planning and performing in terms of the *elements of motions.*

It has been recognized that the chief necessity for both psychologists and managers is for units, methods and devices for recording behavior. These enable all to have at their disposal indisputable permanent records of what actually takes place,—to be studied, analyzed, measured, synthesized and standardized. This need has been met, and there now exist and have been in successful daily use for twelve years units, methods and devices that fulfill every need. These are being applied with success in every field of activity and from their profitable use is resulting a mass of data,—accurate, cumulative, correlated and now solving industrial and other scientific problems.

Finding The One Best Way to Do Work signifies the application of the scientific method to the investigation of records of every motion made, in every line of activity. While no two cycles of motions have ever been made exactly alike as to paths in three dimensions, relative speed, exact speed, direction, etc., the sequences of therbligs or elements of cycles of motions are so comparatively few that any accurate data regarding the activity of the best man obtainable demonstrating the best that he can offer or has been taught, are usable forever on all other work. We have precision

(*Continued on page* 283)

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[1] Discussion of paper "Industrial Psychology" by H. S. Person at meeting of Taylor Society, Cambridge, Mass., April 25, 1924. This was the last manuscript to receive Mr. Gilbreth's editorial attention before his death.

[2] Scientific Management, Addresses and Discussions at the Tuck School Conference, October, 1911, published by Dartmouth College, page 356.

[3] *Bulletin of the Taylor Society,* Vol. IX, No. 4, August, 1924.

Production Control[1]

"The Taylor System in Holt Management"

By GEORGE D. BABCOCK[2]
Manufacturing Executive, Holt Manufacturing Company, Peoria, Ill.

The conclusions arrived at by Taylor in his paper on Shop Management in 1903, together with the methods he described, were based upon the thesis that every organized effort of human endeavor can be analyzed into its fundamental elements, and that these elements can be forecast and arranged in an orderly sequence that represents the best combination to attain the desired result. The analysis and arrangement of the elements of production brought about the two great divisions of productive effort that are characteristic of modern industrial management and production control—planning and performance.

In this paper the author presents an outline of the subject of production control in manufacturing, taking up for consideration respectively actual output with given equipment; preplanning; the establishment of manufacturing programs; determination of lot sizes; establishment of the production schedule; operation analysis; stores systems; dispatching of work; inspection; maintenance; and forms.

THE most efficient type of production management is based upon an application of the principles first laid down by Taylor in his classic paper Shop Management in 1903, and amplified and explained in his later writings and addresses. Taylor's great discovery in management was that scientific analysis should be substituted for rule-of-thumb and for traditional methods. Taylor's work also started the movement to put engineers in charge of the important functions in the supervision of industry, something that had up to that time been almost unknown. As a direct corollary of Taylor's discovery, the greater part of the burden of determining the best methods of doing work was shifted from the workmen to those charged with the management of the business. The reason for this shifting of the burden lay in the fact that such determinations involved many things that were beyond the control of the working force.

Among the items that are not within control of the workmen may be mentioned the following:

a. The raw material used for production; its quality and the regularity of its supply

b. The equipment provided for working this raw material

c. The processes through which the raw material must pass to be converted into finished product

d. The sequence in which the various parts entering into the final product are sent into the factory.

Each of these items requires detailed and extensive investigation before the best combination for the desired final result can be found. Some of these investigations may involve heavy expense and exact technical knowledge, and may consume a considerable amount of time. Obviously, it would be impossible for the workers on their own initiative to conduct these, even if they had the inclination to do so.

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[1] Paper presented at the Prague International Management Congress, Prague, Czechoslovakia, July 21, 1924; also at a joint session of the Management and Machine Shop Practice Divisions of the A.S.M.E. and the Taylor Society, New York, December 4, 1924. In presenting this paper on behalf of Mr. Babcock at the Prague International Management Congress, Mr. Robert T. Kent said in part:

"The company which I have the honor to represent here today has, by the application of the principles described in Col. Babcock's paper, achieved a record which we believe is unequalled in American industry. On July 1 of this year it had maintained for 645 consecutive working days, (on December 19, 789 days) an exactly scheduled production, based on a schedule that was laid down at least five months previous to the date on which the product was delivered to the shipping department. That is, the Company has had to determine, five months in advance, the exact quantity of work that had to be completed on any given day, the quantity varying from week to week and from month to month. For a period of over two years it has not failed, for a single day, to deliver the exact quantity of product called for by the production schedule. This has involved the scheduling and keeping on schedule of over 8,000,000 machine operations.

"The product made is caterpillar tractors, which became familiar in the later years of the Great War; these tractors must be built to stand the roughest usage, yet they must be constructed in accordance with the best standards of the best automobile practice. The fine work involved immensely complicates the problem. The company employs about 1000 men, and operates a foundry, pattern shop, machine shop, erecting shop, and the necessary store rooms and auxiliary buildings."

[2] Formerly Production Manager of H. H. Franklin Manufacturing Company, Syracuse, N. Y.; author of "The Taylor System in Franklin Management."

Taylor's conclusions and methods were based upon the thesis that every organized effort of human endeavor can be analyzed into its fundamental elements, and that these elements can be forecast and arranged in an orderly sequence that represents the best combination to attain the desired result. This analysis and arrangement of the elements of production brought about the two great divisions of productive effort that are characteristic of modern industrial management and production control—planning and performance.

The function of planning includes all of those elements that are beyond the control of the workmen, and some of those that formerly were regarded as within their sphere. It includes a decision as to the material that will be used in the processes of the factory, the exact equipment that shall be used, the method of handling this equipment, the sequence of individual operations on each part of the product, and in the highest development of managerial science, the time that shall be taken for each operation. It also includes provision for instructing the workmen in the methods of handling the equipment so as to insure that the performance of the workman will accord with the forecast of the planning department. Upon the degree to which an industrial establishment has developed and made use of these elements of planning, depends the efficiency of production.

Classification of Manufacturing Effort

Manufacturing can be classified into the following divisions, ranging in order of efficiency from the lowest to the highest:

a. One order for one piece, never to be reproduced

b. One order for several pieces, never to be reproduced

c. Repeat orders at irregular intervals for one or few pieces

d. Repeat orders at irregular intervals for many pieces

e. Repeat orders at uniform intervals for one or a few pieces

f. Repeat orders at uniform intervals for many pieces

g. Continuous or standing orders for the same piece.

Any industry may have in combination one or more of these classes of effort and in any analysis of the industry this should be recognized. The industry should be classified into the above classes and a control plan devised in such a manner as will secure the best results for each class. A general control plan will then be devised so as to relate the classes.

Irrespective of the class or combination of classes into which the work of a manufacturing plant falls, the efficiency of its operation will depend upon two things: (1) The efficiency in selection and use of the mechanical equipment of production; (2) The definite preplanning of every operation and event which takes place in the progress of the work through the factory. These may be considered in some detail.

The Mechanical Equipment

It is obvious that the best equipment that is available for a given purpose is the most desirable. High manufacturing efficiency does not depend upon this, however. Rather it depends on the best possible use of the equipment that is available.

If manufacturing efficiency be defined by the ratio

$$\text{Efficiency} = \frac{\text{Actual Output with Given Equipment}}{\text{Max. Possible Output with Given Equipment}}$$

it will be evident that the efficiency of the plant does not depend upon the efficiency of the equipment *per se*, but upon the efficiency with which that equipment is operated.

Efficient operation depends on the following factors:

a. Maintenance of equipment in perfect operating condition, so that there will be no failures during working hours to delay production

b. Adequate power at the machine, so that it may be utilized to its full capacity

c. Proper adjustment of machines and auxiliary equipment and, in the case of machine tools, properly formed cutting tools

d. Determination of the best methods of operating the equipment, and insistence that these methods be followed

e. An adequate supply of material upon which the equipment may work, so that there will be no idle time or delays due to lack of work for any machine

f. Uniformity in the quality of raw material, permitting uniform operation at a predetermined rate. For example, excessive hardness in castings will compel slower operation of machine tools, and so decrease the predetermined production.

It follows from the foregoing that several departments are concerned in the utilization of equipment to its full capacity. Maintenance, power, and adjustment of machinery are within the province of a mechanical department. Determination of methods and an adequate supply of material at each machine are functions of preplanning. Uniform quality of material is a result of careful purchasing and rigid inspection of purchased material to insure conformity with specifications.

Maintenance can be insured by the establishment of a definite routine of inspection to discover defects, wear or misadjustment which will tend to cause failure or decrease the rate of production. When such are discovered, arrangements can then be made to effect the necessary repairs outside of working hours or at such times as will cause the least interruption to production.

Preplanning

Assuming that the equipment of the establishment is in first-class operating condition, and a routine has been set up that will maintain it in this condition, efficiency of production will then depend on the degree to which preplanning has been carried out.

Preplanning comprises:

a. The establishment of a definite manufacturing program

b. The purchase of materials and the insurance of their delivery in ample time to carry out this manufacturing program

c. The determination of the methods to be used in carrying out the program

d. The sequence of operations to be performed on each component part of the final product (Routing)

e. The establishment of definite schedules to fix the time at which each operation in the routing shall take place

f. The dispatching of the work in the factory in accordance with the schedule.

Another function of manufacturing, supplemental to but not necessarily a part of preplanning, is the inspection of the work, both while in progress and when completed, to make sure that it is up to the standard of quality and workmanship desired. Inspection has this relation to preplanning, that when defective work is discovered, it must be replaced, and the replacements must be fitted into the manufacturing schedule without disturbance or delay.

Establishment of Manufacturing Programs

Manufacturing may be divided into two classes as follows:

a. Manufacturing for stock. Examples of this class are automobiles, food products, certain classes of electrical equipment, typewriters, etc.

b. Manufacturing on orders to definite specifications furnished by the customer. Examples are hoisting and conveying machinery, locomotives, certain classes of textiles, etc.

A manufacturing plant may lie in either or both of these classes. The establishment of a manufacturing program is a radically different process in the two cases, and in the case of the plant manufacturing both for stock and to order the establishment of the program depends upon which class of work predominates.

Manufacturing for Stock

The establishment of a program of manufacturing for stock depends first upon the probable demand for the product. The analysis of this probable demand is a function of the sales department. The accuracy with which this department can forecast this demand is a measure of its efficiency. It is not within the scope of this paper to discuss the methods of sales analysis, but it may be pointed out that in general they should be based upon the same broad principles of preplanning and exact knowledge of the problem as form the foundation of production management.

The analysis of probable sales should show for the purpose of establishing a manufacturing program:

a. The total demand for the product during a given period of time. This period should be as long as possible, and preferably not less than six months

b. Whether or not this demand will be at a uniform rate. If not uniform it should show

c. The variation in demand from month to month, or even for shorter periods if possible.

With these data before it, the management may then plan the productive activities of the plant so as to meet this demand in the most economical manner. Fig. 1 is a graphical presentation of a sales analysis and the resulting production program. Curve *A* represents the expected sales, month by month. Curve *B* shows these monthly sales accumulated to give the total sales at any time after the beginning of the sales program. Curve *C* shows the production program month by month, and Curve *D* the monthly production accumulated to show the total production at any

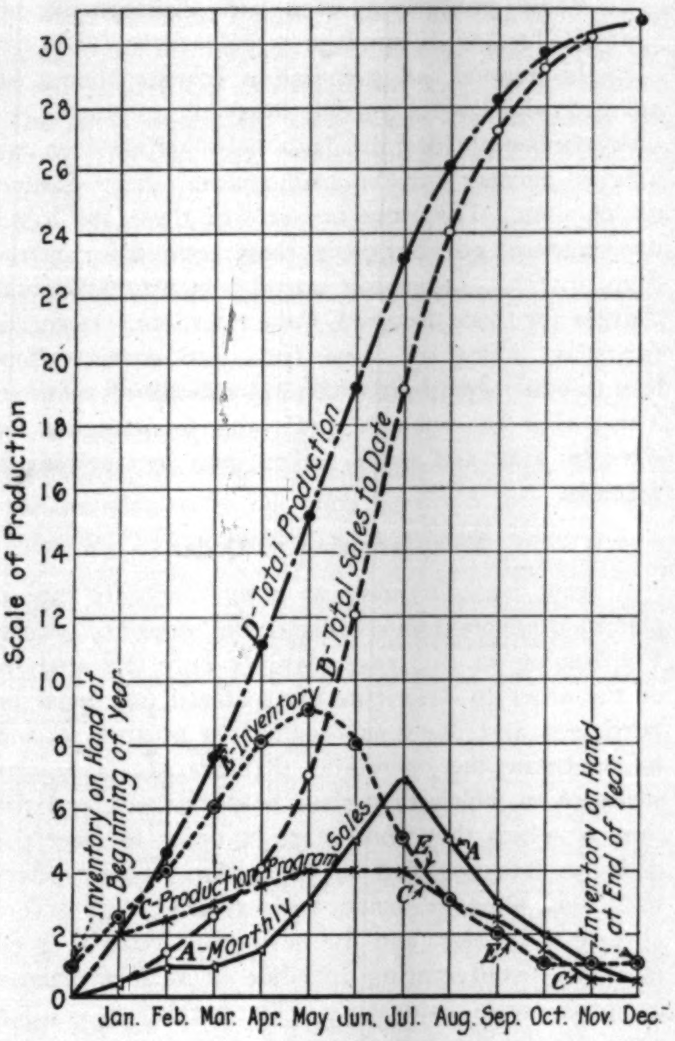

Figure 1

time during the program. Curve *E* is the inventory. The production program should be so laid out that the inventory will never fall to zero. Another curve might be added to show the actual total production in comparison with the planned production. If the production management, however, is efficient, this curve would fall exactly upon Curve *D*.

It will be noted that the monthly production program does not follow the monthly sales program. The reason for this in the case at hand is that there is always a minimum size of lot that it is economical to put through the plant, and this minimum may be larger than the expected sales at the beginning and end of the program. Furthermore, the expected sales at the middle of the program are greater than the manufacturing facilities of the plant, and provision must be made for these by building up the inventory during the early part of the program.

The establishing of uniform manufacture with a minimum amount of labor turnover, and at the least cost, is largely dependent, in an industry where sales vary from month to month, upon the starting of the manufacturing program for a given sales program at the proper time. This proper time is such that sufficient units of product will be built ahead of the sales peak, so that the sales peak will reduce the accumulated product to a normal or predetermined inventory. There may be cases where this slow increase of inventory must be started several months in advance of the peak, for the further away from the peak the accumulation can begin, the less will be the disturbance created by the peak, and the maximum possible operating efficiency will result. A graphical analysis of this character will give a clearer idea of the manufacturing problem than any other presentation.

The rate of production having been decided, the next decision to be made is the size of the various lots of product that must be put through the plant, and the intervals at which these lots must be started in order to meet the production program. These decisions having been made, the production follows the routine described later.

The production program should be analyzed with reference to economical utilization of personnel, as well as for production according to a sales program. If the final product is composed partly of parts made in the factory, and partly of outside purchases, the schedule of deliveries of the outside purchased parts may be scheduled to conform to the sales program, while the production of manufactured parts is maintained at a uniform or nearly uniform rate.

Fig. 2 shows such a schedule as laid out for automobile manufacture. The sales program shows a variation of 70 per cent. The schedule of assembly adopted to meet this variation shows a variation of 30 per cent. The schedule of production of manufactured parts is uniform and has zero variation. Analysis of the product developed the fact that 60 per cent of the cost of materials entering the final product was contained in 59 out of 1330 parts. Of these 59 parts, 44 parts, representing one-half of the cost of material, were purchased finished parts which did not enter into the production schedule until the final assembly. The balance of the other parts entering the car represented such a small relative material value that it was possible to operate the productive labor manufacturing parts on a uniform schedule.

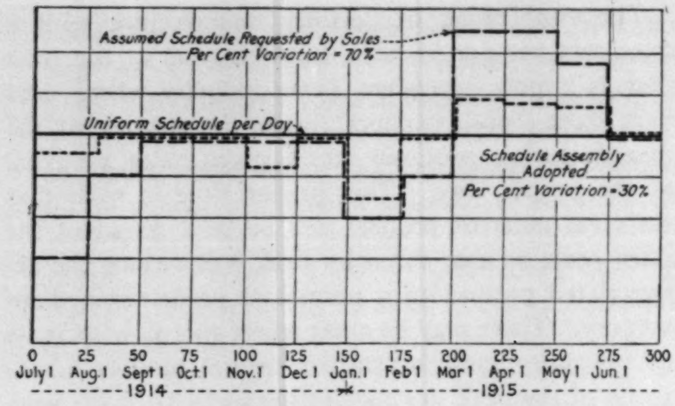

Figure 2

The final assemblies, however, were made according to a variable schedule as shown in Fig. 2.

In arranging the variations of the assembly schedule, a variation in labor of not more than 30 per cent was permitted; i.e., not over one man in every three on the assembly force was allowed to be changed, two-thirds of the force thus consisting constantly of trained men. The cars were assembled according to the assembly, as shown in Fig. 2, and the high-cost materials noted above were ordered for delivery to agree with this schedule. The capital invested in inventory was thus kept at minimum, both for purchased and manufactured parts.

Determination of Lot Sizes

Several factors enter into the determination of the most economical size of lot to be used in manufacture. The first and most important factor is previous experience with similar product as a general guide. The following specific considerations must be taken into account:

Small lots are indicated by:

a. High cost of material

b. Large unit bulk of material

c. Long time required for various operations on a part

d. Probability of change of design

e. Reduction in inventory

f. Conservation of floor space

g. High unit weight of material

h. Use of perishable materials in processes

i. Early entry of part into sub-assembly.

Large lots are indicated by:

a. High average cost of machine set-ups

b. High dispatching, inspection and trucking charges

c. Rapid production, even with elaborate set-up

d. Reduction of spoilage

e. In general, all preparation charges should be satisfied with largest possible lots.

A number of formulas have been prepared at one time or another for the mathematical determination of lot sizes. The more accurate of these are based upon material cost per piece, time required for operations, interest charges on material in process, rental charges for space occupied, wage rates, etc. Accurate formulas, taking all these facts into consideration, lead to cubic equations which are difficult of solution. The author has found it preferable to determine lot sizes by trial and error rather than by applying a formula.

Manufacturing to Order

A plant manufacturing to order obviously cannot plan its production in advance of the receipt of orders. Preplanning in this case involves only the analysis of the order to determine the material that must be purchased and the time required to procure it, and to determine the operations that are necessary, the sequence in which they shall be performed, and the time at which they shall start in order to meet the delivery date specified in the order. These determinations must be made with reference to orders already in process, and the new order must be fitted into the manufacturing schedule in such a manner as not to create disturbance. The purchasing is often simplified by the fact that most manufacturing concerns of the class under discussion operate in a somewhat limited field as regards product, and the raw material used for all orders is of the same character. Thus a company specializing in hoisting and conveying machinery will use for practically all of its orders pig-iron, sheet and bar steel, alloys and certain standard manufactured products such as rivets, bolts, pillow blocks, chain belts, etc. These it will keep on hand in sufficiently large quantities to fill its requirements over a certain period, purchasing in large lots whenever the stock falls to a predetermined minimum. If the analysis of the order shows that there is sufficient raw material available to fill it, production can begin at the earliest date on which machine capacity is available.

Another class of manufacturing which is to order, but which has many of the characteristics of manufacturing to stock, is found in certain phases of the textile industry. In the manufacture of woolen fabrics for dress goods, orders are taken by means of samples for varying quantities of product of different grades and patterns from numerous customers. The small orders for each fabric are combined into single manufacturing orders, from which a manufacturing program is built up. Since the samples are sent out and orders taken before the manufacturing season starts, the mill is enabled to plan a production program in its entirety before actual production begins.

Manufacturing for Stock and Order

Where manufacturing for stock predominates, the stock program is laid out as heretofore described, and the product made on order is fitted into the stock program. This may be accomplished by ascertaining what proportion of the machine capacity is not utilized over a given period for stock manufacture, and then scheduling the special product through this excess capacity as if the balance of the equipment did not exist.

Where the stock production is of minor importance, it is scheduled on the basis of the excess machine capacity available. In doing this, if the stock program extends beyond the time for which special orders on hand will utilize the equipment, care must be taken to reserve sufficient capacity to handle future special orders. The capacity so reserved should, in general, be equivalent to the capacity which has been required for special work during some definite preceding period, say for a period of from one to six months.

The Purchase and Storage of Material

In purchasing material these considerations must be taken into account:

a. Quality
b. Price
c. Time of delivery.

Quality is important, especially where the final product must meet specifications as regards strength, durability, etc. It is also important in that it may affect the time required for completing the processes in manufacture, and if of different quality than that upon which the manufacturing program is based may require much more time at each operation. The program then cannot be carried out as planned, except at the expense of overtime or the utilization of more machinery and men than were contemplated. It is poor economy to substitute material of unknown quality for that of proved quality to gain a slight advantage in price.

All things being equal, the lowest priced material is to be desired. If, however, the quality is lower, or delivery cannot be insured at the desired time, price becomes less important than other considerations. The time required for delivery is extremely important in laying out a manufacturing program. Since production cannot begin until there is material upon which to work, ample time must be allowed in which to procure material. It is advisable to tabulate the maximum and minimum number of days required for each item of material that is commonly bought, as a guide in placing orders. The reputation of the seller for keeping delivery promises should also be considered, and preference given to the one who can be relied upon, rather than to one who will promise a prompt delivery but whose promises are unreliable. It is better to accept a later delivery date, with the knowledge that it will be met, than an earlier date where there is reason to doubt that delivery will be made on that date. Another factor to be considered is whether the material shall be bought from the mill or from a warehouse or jobber. Purchases from the mill usually cost less, but the time required for delivery is longer. Whenever possible, mill purchases are advisable.

It should be borne in mind that the shortest time required for the execution of a manufacturing program is the longest time required to procure any item of material plus the time required for the longest process through which that material must pass. The importance of accurate forecasts of the time necessary for purchasing is thus evident.

In the routine of establishing a manufacturing program then, the first item is to ascertain when the first orders for material must be placed. To do this it is necessary to work back through all the processes of production, starting from the time when the finished product must begin to leave the factory. The methods of doing this are explained later. This analysis of the operations fixes the time at which the material for each process must be available. To this time is added the length of time necessary to obtain prices and secure delivery. Having thus fixed the number of days that must elapse between placing the order for material and the completion of all the manufacturing operations, exact dates can be set for the beginning of each event in the production program. This is known as scheduling.

Establishment of the Production Schedule

In making a schedule for manufacturing, the completion of the final operation is the starting point. The number of days that must be allowed for each standard lot or operation must be ascertained. The length of time that must be allowed between operations for movement of material, for inspection, for seasoning or for any other purpose whatever also must be determined. These various intervals are then to be added progressively to show the number of working days prior to the date set for completion of the first lot of the product that each operation should begin. Then by means of a calendar, from which Sundays and holidays are omitted, the actual calendar dates for these operations can be fixed when the date of completion is known. Table 1 is an example of the fixing of the calendar dates for the principal events in the production of a cylinder for the gasoline motor of a tractor, deliveries of which are to begin on July 1.

TABLE 1. PRODUCTION SCHEDULE FOR CYLINDER OF TRACTOR MOTOR

	Finished tractor	Assembly	Machine shop	Rough stores	Purchase	Engineering
No. of days in department	0	22	24	17	60	10
Working days ahead of completion	0	22	46	63	123	133
Date work should be finished	July 1	June 5	May 7	Apr. 7*	Feb. 7†	Jan. 25

*Date on which invoice should be paid.
†Date on which purchase order should be placed.

This cylinder is a machine shop product, on which many operations are performed. The actual working schedule would show in detail every operation, and the date at which that operation should begin. Several ways of doing this are in common use, and each one has its advantages. No one method can be said to be the best, for the reason that the method to be adopted should depend on the circumstances surrounding its use. Two methods that have proved very successful may be cited.

The first uses what are known as route sheets. One route sheet is used for each item of product, and lists in order every operation through which the item is to pass, together with the machine, and the date on which the operation is to be performed. Progress of the work is noted by checking off each operation as it is completed. When an operation is checked off, the orders for the next operation are issued on the date set opposite that operation. The route sheet may be used for large quantities or for single piece orders.

The second method is semi-graphical. Consider for a moment a single item of product that is made up of many parts. If a horizontal line is divided according to scale of working days, it can be made of such a length that the number of days represented by it is the total time from the completion of the design to the delivery of the final product. Then the schedule can be laid out by noting on this line, according to the scale of working days, the number of days prior to completion that each operation shall begin. The time required for this operation may be shown by blocking off on the line a distance equal in length to the space representing the number of days required. This space is laid down from the point denoting the beginning of the operation toward the point representing the completion of the product, known as the zero point. Another scale, also graduated to the same scale of working days, but reading from right to left in calendar dates, with Sundays and holidays omitted, is then laid along this line of operations, with the date set for completion placed on the zero point. The calendar date on which any operation should begin may be read directly on this scale. If for each item that enters into the final product a similar horizontal line of operations be laid out, there is presented a graphic picture of the production schedule for the entire product.

Such a graphical schedule may be used to control production by the addition of another scale, equal in length to the total time shown on the schedule for the part requiring the longest time. This scale is graduated to read in items of finished product, and is numbered from right to left, from zero to the total number of items in the program. This scale is movable, and at the beginning of the program is set with its zero at the extreme left of the schedule, and corresponding to the first operation shown. It is moved to the right each day a distance equal to one day on the horizontal scale. Whenever the zero of this moving scale passes over any operation posted on the schedule, it is an indication that that operation should begin. The necessary orders should then be issued for such operation.

Progress of the production program can be recorded by writing over each operation in terms of units of final completed product, the quantity of product that has passed through it at the end of any period of time. If the number so written corresponds to the number immediately over it in the moving scale or schedule tape, the operation in question is in accord

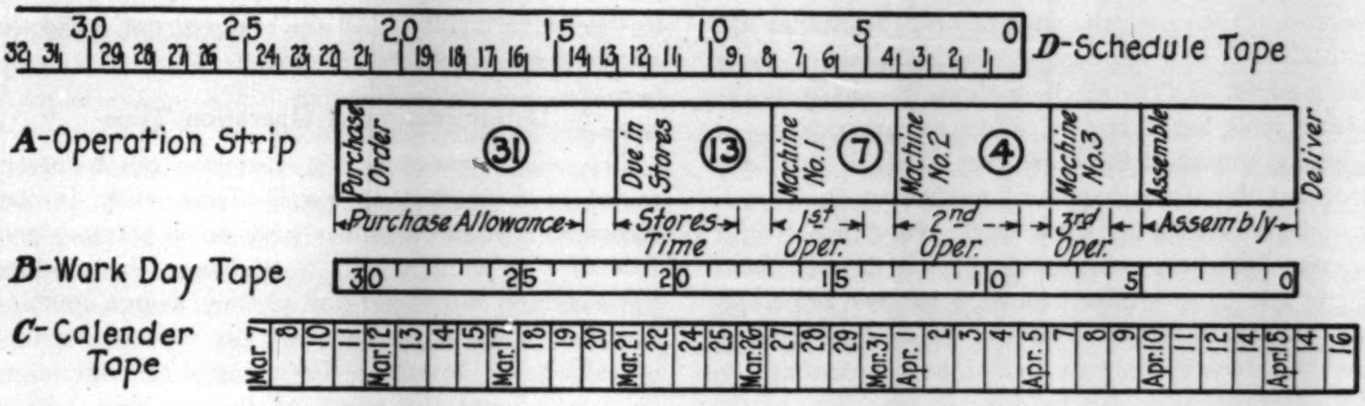

Figure 3

with the schedule. If the number is greater than that on the schedule tape, the operation is ahead of schedule. If it is less, the operation is behind schedule. The number of days that it is off schedule is ascertained by locating on the schedule tape the number corresponding to that written on the operation, and noting on the scale of work days the interval between the position of this number and the operation in question. (See Fig. 3.)

This method is the basis of control boards that have been used to control operation in repetitive work, where the product is put through in lots, as in the automobile industry. If it is desired at any time to increase the schedule, this may be done by decreasing the time interval at which lots are started in the factory.

The route sheet and the control board are adapted to industries where the product is made up either of single pieces or of a large number of parts that are assembled into a final product. Where the final product is not an assembly, such as cloth fabrics, or where it is an assembled product made in such large volume that the manufacture of each part is on a progressive or continuous basis, scheduling is determined by the speed of the final operation. This determines the amount of product that can be produced per day, and the purchase of material is arranged so that there will be daily supplied to the factory equipment an amount equal to the daily production. The only date to which much consideration must be given is the date on which the first purchase order must be placed. This is fixed by the time required for process up to the final operation plus the time required to procure material. After the flow has once been established, the operations become automatic in their relation to one another. In certain continuous processes, the speed of production is governed by the speed of conveyors which transport the work in process from one operation to the next. If it is desired to speed up the schedule in such a case, it is done by increasing the speed of the conveyors, or by decreasing the intervals at which material is delivered to them for the first operation. Additional machine capacity must then be added at each operation to take care of the heavier flow of work.

Operation Analysis

It is evident from the discussion on scheduling that an important feature is exact knowledge of time required for each operation. It is not enough that the time for an operation by the method in common use be known. For the most efficient management, the time of the best method should be found. This includes both the best method of performing each individual operation and the best sequence of operations.

A prerequisite to efficient scheduling, then, is an exhaustive analysis of each operation to discover the best method and equipment for performing that operation. This also should include an investigation to discover and eliminate all causes that will hamper production, and to standardize the conditions under which production shall be carried on.

For instance, in machine-shop work there may be several methods available for performing a single operation. Boring and turning may be done, for example, in a lathe, a boring mill, or a turret lathe. Considerations that govern the choice of the particular machine in this case might include the size of the work, the number of pieces to be made, the quality of finish demanded, the relative time by each method, the number and cost of special tools, and the time required to set up each machine for the operation in question. The analysis should first determine the method, and next standardize the conditions of using that method. In the machine shop, the shape of the cutting tools has a marked effect on production. It is highly important therefore that these be standardized, and the same shape and method of heat treatment be used for the same work every time that it occurs. The best combination of speeds and feeds should also be ascertained for each job, and the workmen should be required to use these combinations. The machines themselves should be standardized so that identical work can be done in machines of the same class. If this is not done, there may be a congestion of work at some machines while others of the same class are idle because they are less efficient than the others. Or if the work is routed to these inefficient machines it may not be possible to do it in the time allowed in the schedule, which should be based on the best method. The schedule may thus be upset at these machines with disastrous results so far as controlled production is concerned. Standardization is a great aid to simplification of routing and scheduling.

Similar considerations obtain in other industries. In the textile field, for example, the speeds of spinning frames and looms on the same class of work should be standardized, otherwise the production will become unbalanced due to one operation producing more than the next can handle.

Quality of Material

Uniformity in quality of material is an important factor in scheduling. In the analysis of a job a certain standard of quality is assumed, and all time estimates are based on this. Variations from this quality may seriously affect the time of operation. Thus in the machine shop, a certain grade of iron castings can be machined at a certain best combination of speed and feed with a certain depth of cut. If the casting actually furnished is harder than that used as a basis, the speed or feed must be decreased or more cuts taken than were contemplated. In any event, the time required will be greater and the schedule will suffer in consequence. In textiles, insufficient strength in the yarn due to improper blending of the raw material may cause frequent breakages of yarn, resulting in a shutting down of the machine with consequent loss of time, or in defective product.

Uniformity in quality can be insured as a rule by rigid inspection of raw material accompanied by tests to determine quality. All the material not up to the standard set should be rejected.

Determination of Operation Time

The time required for an operation can be ascertained in a number of ways. Time study is one. Estimation, based on similar work or on previous performance is another. In work where the machine has a definite output per unit of time, as in a spinning frame or loom in textile work, the time is a matter of calculation, based on the quantity of material to be handled and the speed of the machine, with a certain percentage added to cover unavoidable machine delays, and the setting up of the machine. In machine-shop work, where the time required for handling the work and for setting up the machine is relatively small, compared to the time actually required for cutting metal, calculation based on feed and speed and the dimensions of the work, plus a percentage of flat time allowance for handling, etc., may be sufficiently accurate.

While it is desirable, of course, that the time allowed for an operation be as accurate as is possible, it is unwise to strive for absolute perfection when the advantage to be gained is small, and the cost of the last few per cent in the perfection scale is high. Thus, if the handling time on an operation is two minutes, and the machine time 30 minutes, an error of even 25 per cent in estimating the handling time will make an error of only about one per cent in the total time of the operation. The actual length of the job, however, must be considered, in deciding whether or not the error due to estimating will be serious. In the case just considered, an error of 25 per cent or one-half minute per job, would amount to but 7 minutes per day, since less than 16 jobs are all that are possible in an eight-hour day, and the maximum difference in production would be one piece per week. If, however, a job requires but three minutes with a handling time of one minute, an error of 25 per cent in estimating handling time would be more serious. The difference in product would be one piece per hour, or eight per day.

Time study has not the same relative importance that it held at the beginning of the movement for better industrial management. Several reasons for this exist. In the first place, an enormous amount of time study data have been accumulated and published. These data cover the smallest elements of the work to which they relate, and by combining these elements the time for the great majority of operations can be predetermined with considerable precision. Another reason is the standardization of equipment. Formerly hardly two machines designed for the same work were alike in their characteristics. At the present time there is a remarkable similarity in the characteristics and capacities of machines of the same class, even when built by different makers. Then, too, improvements have been made so that the time for adjustments and manipulation is much reduced, and as a rule, forms but a small fraction of the total time for operation. Machine capacity for a given job can be determined from tabular data or by calculation, aided by slide rules if desired, and in most cases, the machine time is the most important factor. There are many things to be done in the line of standardization, establishment of material control, etc., before a factory is ready for time study. And as Mr. C. G. Barth has aptly said, "When these things have been done there will be little need for time study."

Stores Systems

The stores system is an important feature of production control. Unless there is an adequate supply of material available when and where it is needed, the most elaborate system and the finest equipment will fail of their purpose. The stores system includes the storage of material and the accounting for it. The accounting system should be so designed as to show at all times the quantity of material of each class and size actually on hand in the store room, the quantity on order but not yet delivered, the quantities apportioned to or reserved for various orders not yet in process, and the particular orders to which these quantities are assigned, and the balance that is available for future orders. The stores ledger sheets should also show the location in the storeroom of every item carried, and the unit value of these items. This last feature enables inventory to be taken directly from the stores ledgers without the necessity of a physical inventory in the storeroom.

In the storeroom, each commodity should carry a bin tag, on which is entered the quantity of material in storage. Additions to the quantity on hand should be entered on the tag, and added to the total already entered. Material issued should be deducted from the bin tag total and a new total brought down. The total quantity shown on the bin tag should always correspond with the quantity shown as on hand in the ledgers, and frequent comparisons should be made to detect errors.

No material should be permitted to leave the storeroom, except on the authority of a stores issue order, signed by some one with the necessary power. Neither should material be received unless accompanied by the necessary documents to show its origin. These, as well as the stores issue orders, should pass through the hands of the stores ledger clerks to insure that the ledgers will be kept up to date.

Dispatching of Work

Except in continuous or progressive manufacturing, dispatching is essential to make preplanning effective. Dispatching is the assignment of jobs to machines or workmen in the sequence and at the times determined by the schedule established in advance. Under modern management, the foreman or overseer has no authority to dictate when or where any operation shall be performed. The time of its performance is fixed by the schedule, and the place by the job analysis. Work orders then are prepared for each operation shown on the schedule and filed according to the schedule dates. Each day the orders for that day are issued to the workmen concerned. If the work called for by any work order is not available, due to previous operations being incomplete, the order is marked in some manner to make it conspicuous, and pressure is exerted until the work is once more on schedule. Dispatching thus may be performed by a well-trained clerical force and foreman relieved of routine. By noting on them the time of issue of work orders, and the time of completion of work, the dispatching may be used as the time keeping system of the shop and also to accumulate data for the cost accounting.

Inspection

Inspection under modern industrial management is used to prevent defective work, as well as to discover it in completed product. Defective product results only from the two causes of defective material and poor workmanship. The inspection function can be arranged to prevent both of these causes. Inspection of incoming material has already been discussed. As a preventive of poor workmanship, inspection should take place at the beginning of a job. The inspector should ascertain whether the product at each operation is being made according to the specifications, and if not, point out the cause of variation. He should not leave until the workman has produced and is producing perfect work. The dispatching of work should include the directing of the inspector to operations that are just being started.

This inspection of work in process should not operate to dispense with final inspection of each part of the product after the last operation. In final inspection, the inspector should be advised as to just what faults or variations from standard are to be looked for, and the permissible amount of variaton. The provision of a definite routine for inspection will render it more efficient and less costly.

Maintenance

Maintenance and repair form an exceedingly important function of production management. The duties of the maintenance department include the repair of equipment that fails or wears in service, and the establishment of a system of inspection and preventive repair that will remove causes of failure or make adjustments for wear before failure occurs.

Failure of equipment in service has many disadvantages. Not only is there the cost of repair, but also the wages of idle workmen while repairs are being made, and the loss of profitable production. Constant machine failures will prevent any schedule being laid down with the certainty that it can be met, and production control may become difficult if not impossible.

The maintenance department can avoid all or nearly all of these difficulties by establishing a routine that will insure inspection of the equipment of the plant at regular intervals. When conditions are revealed that require a remedy, arrangements can be made for the necessary repairs outside of working hours or at a time when they will cause the least interruption to production. It is worthy of note that those plants that have a highly developed maintenance system seldom have equipment failures.

Forms

To carry out the routine of any system of management, certain forms are necessary. The system of forms should not be confused with the system of management. The latter is an organized scheme for obtaining certain results, based on definite principles. The former is simply the mechanism provided for the latter. And let it be stated here that scientific management is not a particular system, nor a set of forms. These are but a means to an end. They represent only the easiest and most economical method of applying the principles of management to the case in hand. Two plants may have entirely different systems and their forms may be totally unlike, and still both plants may be truly representative examples of scientific management. Forms are merely a permanent statement of the wishes of the management in regard to the matters to which they relate. They replace orders and instructions that in the early stages of an enterprise or program are given by written memoranda or verbally. When an order or instruction is repeated sufficiently often to warrant it, a form is devised to convey the same information, concisely and definitely, leaving only the necessity of writing in the figures, dates and symbols to make the form complete. Forms may also be considered a delegation of authority to the individual authorized to issue them, the authority, however, extending only to the subjects covered by the form.

THE effectiveness of financial self-interest as a motive to regularizing production depends on how closely the differential costs borne by the employer correspond to the true differential costs of added production to the industrial community as a whole, and how closely the residual or constant costs of the employer correspond to the burdens which the industrial community must bear whether production is maintained or not. (J. Maurice Clark, *The Economics of Overhead Costs*, p. 167.)

Planning and Production Control[1]

The Committee on Industrial Planning of the Boston Chamber of Commerce presents a composite picture of the planning methods found effective in Boston's most efficient factories.

I. Organizing for Master Planning

A. What Master Planning Is

A WELL balanced and economically directed business must have worked out in advance a Master Plan which in turn is broken down into detailed schedules and budgets for Sales, Finance, and Production. It is obvious that the various elements of a business cannot be expected to work together as a unit except through the use of a coordinator or a Master Plan.

It is very doubtful if there exists any unanimity of opinion in regard to either the character or scope of a master plan. This paper is prepared on the basis that a master plan covers solely *future* operations (not current operations) and that it specifies the duties of each division of the organization affected by the plan and a finish date for the completion of the work of each division.

B. Purpose and Benefits

The usefulness of a master plan is founded on the necessity of translating market possibilities into a goal of production output which can be sold at prices affording a margin that will satisfy requirements for dividends and reserves. The benefits which result from the use of a master plan are many. Selling promises, as to quantity, quality, and delivery are kept and hence satisfied customers are one of the outstanding results. Idle time and overtime for both men and machinery are reduced to a minimum. Purchases are made at such time as to realize the most for the money expended and made far enough in advance so that suppliers are not constantly rushed to meet deliveries. Better relations with the banks are promoted, for only that which can be financed will be attempted; the banks will know in advance probable needs and will be prepared to meet them; and also definite knowledge is available as to when and how notes will be met. Consequently by the use of master planning, or foresight, better control of the business cannot help but result.

C. Work of Master Planning

The well balanced and economical plan of action worked out as a master plan should be based upon the following salient principles:

1. That the sales estimate should be matched against existing inventory.
2. That the resultant production schedule should be transposed into man hours.
3. That these man hours should be distributed to departments or processes.
4. That these hours should be matched against the existing personnel in the form of a direct labor budget.
5. That these hours should be transposed into money, making an expense budget.
6. That an estimated profit and loss statement should be prepared.
7. That an estimated balance sheet should be prepared.

D. Steps in a Master Plan

In order to develop true coordination of sales, production and finance by means of a master plan, six steps may be taken. They are—

1. Research
2. Analysis
3. Synthesis
4. Planning
5. Scheduling
6. Inspection

1. Research

By research for master planning is meant the gathering of information covering the potentialities of the market, the plant, and the financial resources. The master plan is based on multifold forms of research. One large phase—the one involving the most work—is the establishment of a sales quota. Into the consideration of this enters the present and potential factor of—

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[1] Reprinted by permission of the Boston Chamber of Commerce from *Current Affairs*, issues of December 3, 10, 17, 24, 1923.

(a) The Market
1. Types of consumers
2. Geographical distribution of consumers
3. Types of distributors
4. Geographical locations of distributors
5. Statistical data of consumption
6. Trends of fundamental economic conditions
7. Competitor activities
8. Sales expense, and many other items

(b) The Plant
1. Equipment
2. Capacity
3. Labor conditions
4. Raw material conditions, and inventories
5. Costs

(c) Financial Resources
1. Funds for additions to plant or equipment
2. Funds for advertising and sales promotion
3. Funds for purchasing programs
4. Funds for personnel programs, and other items.
5. Ratios

The necessity for accurate and comprehensive market information sufficient in scope to determine manufacturing policies and to lay out running schedules makes it necessary to give the types of sources from which such information can be secured.

(*a*) *Statistical Services and Publications.* Certain organizations collect and tabulate information from basic industries which present an excellent measure of business conditions, and form a basis for rather accurate forecasts so far as general conditions are concerned. The indices most commonly used are interest rates, wages, commercial paper, "20 average industrials," iron and steel production, unfilled steel orders, rediscount rates (Federal Reserve Banks), commodity prices, "cost of living," unemployment ratios, building permits, automobile output and registrations, gasoline consumption, crop forecasts, such as grain and cottons. The most prolific sources of statistics are the Department of Commerce, Bureau of the Census, and the Department of Agriculture.

Granting that these statistical measures of business form an accurate basis for prediction, there seems to be a wide gap between these forecasts and their application to the individual business.

(*b*) *Advertising and Research Service.* These organizations offer a method of amplifying general statistics and applying them to an individual business. In market research the main value of such an agency is the rapidity with which the market can be covered; a knowledge of the customers' reactions to goods and to selling methods, and the fact that the name of the firms making the investigations does not appear. The disadvantages are the danger of a superficial investigation due to a lack of accurate knowledge of the goods and of the methods of marketing and the danger of the personal equation of the investigator entering into the work, and of the "advertising slant" biasing the entire report.

One organization has successfully avoided those dangers and operates as follows:

1. Conference in which the scope of the investigations is outlined in detail—even to the questions to be asked.

2. A short period of training for the field men—who are not advertising salesmen.

3. Reports and interviews submitted at very short intervals—in order to insure the proper control of the investigation.

4. A final report in which the questions prepared in the original conference are presented in tabular form with the answers arranged so as to indicate the "market value" of the firm giving the information.

(*c*) *Research by Individual or Cooperating Firms.* This is probably the best way that general market trends, as developed from basic statistics can be applied to an individual business. This type of individual research sometimes known as "sales engineering," embraces product analysis, i.e., a comparison with competitive brands as to quality, cost, put-up, distribution; sales analysis as to volume, territory, etc.; market analysis, new markets, new uses for products. Cooperating firms such as trade associations, etc., in theory cover this same ground at a much lower unit cost. The value of such an association lies in the degree of support of the members, and the amount of information concerning their own business which they are willing to contribute.

In individual research salesmen furnish an excellent point of contact. A list of two or three questions, such as stock on hand, future demand, and new lines or customer development would aid greatly in manufacturing and planning policy work. The salesman is of greatest value as a check on information secured from other sources. Where there is a lack of definite facts concerning any market developments, special research men may be employed. It is imperative that their opinions be checked against information furnished by the salesmen. The use of special research men should be considered only where the cost of their services per pound or other unit is sufficiently low to be no more of a factor than an advertising appropriation, and then only when there is a specific policy covering collection and analysis of market information. From these sources, information should be collected and presented to the responsible executive merely as a series of facts so arranged as to enable him to make the necessary decision. In cases where opinions even from responsible sources are given, they should be given as opinions, and should be accompanied by all available facts, both in support and in opposition.

2. Analysis

Analysis for master planning is the compilation of research data into reports, tabulations and graphs to make the information available and comparable for the next step. Statistics should especially indicate the part in which the individual firm may or may not follow the indicated trend. The value of this method of building up within the organization an analytical study of sources of information lies in the accumulation of fact and of experience within the company sufficient to make safe comparisons and to work out sound development policies.

Analysis most often comes down to a form of statistical operation. Rarely, however, does this suffice for complete analysis. Someone has well said "You can transmit knowledge but not experience." Therefore, research should bring together all possible opinions of experienced men and these should be digested as a part of the job of analysis. The analytical man should have capacity for expression of his conclusions in a report to the management, outlining the standard or goal upon which management is to decide as the basis for a master plan.

3. Synthesis

Having compiled and analyzed the data, the next step is that of synthesis. All the separate elements, as revealed by the research and analysis, are combined into a logical and complete whole. In other words, this is the time when a definite goal is established. The general limits and requirements of production, as well as those of sales and finance, are outlined. They will show which articles must be manufactured, the quantity of each to be produced and the design of the products, the type of labor necessary, and the cost and profit on each item. Limits, tolerances, and degree of quality and finish, as well as kind of raw material, are determined. Standards of performance are set up which are thoroughly investigated and are possible of attainment.

The establishment of a goal is a management policy decision and must precede planning. This means that we must gather all information bearing upon the problem, analyze it, and set up a standard which is to be the goal of a master plan. With this established, the planner then determines what departments will be affected and what parts they are to play in reaching the goal. A master plan is usually ineffective unless, in the process of formulating it, an agreement has been reached with each department head in regard to his part in the schedule of operations. A master plan cannot be superimposed from the top; it must be built up from the bottom.

4. Planning

The planning step is the formulation of the different master operations in a sequence which will make the goal attainable. Some one individual, or a group, who knows the policies of the organization and the system and methods of the plant departments is best suited to plan the sequence of operations. Where to draw the line between master and detailed operations is always a problem. It is a mistake to go into detailed operations where not absolutely essential. A master plan should be a concise condensed document, as its purpose is to give the management a guide to the sequence of operations as a means of coordinating activities. Where it brings in new methods it must clear up any uncertainties, but where existing methods or routines are involved it should be exceedingly brief.

5. Scheduling

Scheduling is the planning of the time factor for each master operation so that the sequence of operations may be performed and the goal attained with the least expenditure of time, effort and resources. Here is where the master plan functions to good advantage. It aids in cutting out wastes and interferences. It enables the departmental planners to grasp the relation of their operations to the general plan and to the plans of other departments. Charts of actual versus scheduled performances enable management to act before emergencies arise.

It has been stated that only the date of completion is of real importance. Yet even this cannot be arbitrarily maintained for the human equation and acts of providence interfere. It must be a standard but in practice you must provide an element of flexibility. That is why the written plan and schedule are so much more valuable than the unrecorded decision of a committee. Changes should not be permitted without the consent of the management. No master plan can be final until the job is done. The work of this division is a continuing work; the plan need rarely be changed, but the schedule is alive and not a static thing, and coordinated rescheduling may go on frequently without necessarily impairing the usefulness of the master plan.

Usually the wisdom of sending the complete plan to all parties concerned is open to discussion. The executive heads of major divisions of the business should have complete copies, but the minor executives need have only those sections in which they are directly concerned.

6. Inspection

Inspection is the checking up of results as the work is progressing and after it is finished. The master planning division should be held responsible for following schedules of performance and should report to the management any deviations from the plan of schedule. This is highly important as better planning will follow the checking up of the performance of previous plans. It leads to real cooperation.

E. Personnel for Master Planning

The men best adapted for master planning are of the creative, analytical, imaginative type—the engineer type. The training for the work is essentially that of the engineer, although it does not follow that only graduates of technical schools will satisfactorily meet the requirements. The school of life in its human, industrial, and commercial contacts will often fit a man for the work if he has the aptitude for observation and analysis. In a general way it is difficult to discuss the personnel for master planning. The final product—the master plan—must take a form to meet the individual needs and type of organization of the particular business enterprise.

F. Types of Master Planning

There are two general types of master planning organization. The first is adapted to the business making a single related line of products. In this case there will usually appear a functionalized form of organization. We may find (1) field investigators, (2) bibliographical or desk investigators, (3) statistical investigators, (4) planners, (5) schedulers.

The second form of master planning organization is usually found in a business dealing with diversified unrelated lines of products. In this case we find no clear differentiation of functions. Occasionally this organization is called a "merchandising department." It confines its operations to the research and planning work of a single line of products and there are as many merchandising divisions as there are definite, diverse lines of product. Usually, however, even in this type the statistical and research functions are centralized. Separate specialized staff divisions perform these functions for all parts of the business. Frequently, also the planning and operating functions are united. The master planning for the whole business is done by a committee of merchandising, sales, and production executives and the result of the committee's work constitutes the master plan for the whole business.

II. Determination of the Method of Control

CONTROLLING the manufacture of the product is probably the most important factor in putting across a master plan or budget of the business. Upon this control depends the economical manufacture of the product. It insures a constant flow of product to meet the sales schedule and the least possible waste in time and money due to the idleness of machinery and labor.

A. Gathering the Facts

Many factors of varying importance affect the type of control to be developed. Having determined in advance that control of production is desirable and necessary, the next step is to decide upon the proper type of control.

1. Type of Industry

The industry itself will determine the broad principles, for all industries fall into three groups; (1) assembling; (2) continuous; (3) a combination of both. A straight line industry will naturally need a very simple and more or less automatic control. The assembly plant, however, usually presents a more complicated situation and therefore requires an entirely different method of supervision.

2. Type of Manufacturing

After deciding to which of these groups the industry belongs, the question is whether the products should be produced (1) to order; (2) for stock (3) both.

If the number of lines are few the problem is comparatively simple and the amount and kind to be produced can be planned a long time in advance. This can also be done in certain cases of manufacturing to order, especially in industries where orders are placed far in advance and in large quantity. In most instances this is not true, and extremely careful consideration must be given to the problems of when and how much should be made.

The first classification, as in the making of rubber footwear, can be governed by an order control, either by breaking down the original order into its different elements or by grouping orders for similar parts having the same delivery dates. The second, manufacturing for stock, can be considered along with the third—which is a combination of both manufacturing for orders and manufacturing for stock. This condition, which necessitates a part or product control, is highly emphasized in the manufacture of watches and speedometers with their many parts of intricate design, their sub or minor assemblies, major assemblies, and the complicated final assembly.

3. Types of Product

The type of the product has a direct bearing on the control methods. A concern manufacturing a crude, cheap article and one manufacturing scientific instruments have entirely different problems. It has been proved in numerous cases that rapid production and quality production do go together. However, in cases where workmen are extremely scarce and highly skilled, where the necessity for quality is a dominating factor and where cost is a minor consideration, it is highly advisable that the management proceed slowly and cautiously in developing a system of control.

4. Equipment, Processes and Material

Other important items are the kinds of machines and equipment. Automatic and specialized machinery present different problems from those of bench work or simple progressive assembly. The processes and machinery may be more or less standardized. As a general rule they can be highly standardized. With materials the situation is different. Certain materials are by nature hard to deal with; wood, for example, is much more difficult to standardize than steel. The methods of handling materials, however, may be highly standardized in many cases.

5. Size of Plant

An extremely important factor is the size of the plant. A small factory may be controlled by means that are in principle entirely inadequate for a large concern in the same line of business. The size of the business is an excellent measure of the type of control for labor, tools, planning, and production.

6. Layout

The layout of the plant is important. A modern plant, with large floor areas and all buildings having the same floor levels, presents a different situation from that of an old crowded set of structures with varying floor levels. The layout usually affects the physical movement of work as much as any other single factor.

7. Departmentalization

The extent of the departmentalization is vital. In cases where the products are manufactured in interrelated departments a tight and complicated control must be established. The problem is more simple if the departments are not so interrelated; that is, if one department or a group of departments make the product from the raw material through to shipment.

8. Delivery Dates

Delivery dates are all-important in seasonal businesses. The consumer or distributor will not accept the product after a certain date. In order to continue in business the manufacturer must have a comprehensive method of determining assembly and delivery dates in advance and of seeing that they are lived up to. Even in non-seasonal businesses establishing and honoring delivery dates is highly desirable. More friction between producer, seller and consumer has been aroused by failure to live up to promises than by any other cause.

B. Determining the Type of Control

The group of facts which have just been discussed can readily be determined for any business; it is a matter of inspection. Certain of these items are permanent; others can be modified. After the facts are all in mind and stabilized the decision as to types of control can be made.

1. Centralized or Decentralized Control

There seems to be a great deal of discussion as to whether centralized or decentralized control is best. Two schools of thought have developed around this point, but it is becoming rapidly apparent that no one type is best for all cases.

The term centralized as applied to production control implies that each function or group of functions is under the control of one person and is performed in one place. In a sense, anything short of the complete centralization indicated would be termed decentralization. In actual practice, however, the important thing is the degree of centralization. In decentralized control the major plans are worked out in the central office in order to secure coordination and then the details are delegated to the individual departments. In either case, however, the object is always to secure the maximum economical *control* under the given conditions.

(*a*) *Size.* In order to perform all planning, scheduling, and dispatching for the entire plant at one central point the plant must be comparatively small. Size is the primary consideration in deciding between centralized and decentralized control. A plant like the Watertown Arsenal is too large for central control. However, a central planning office may do the master planning; that is, materials may be secured for the entire plant and delivered on time to the individual departments. Where the work is to be done and when each department will start and finish each order can be specified, but it would be extremely inadvisable for the central planning room to attempt to specify when each job on each machine or process within the individual department shall be performed. These details must be left to the individual units in a large plant.

In a small plant the situation is reversed. By decentralization the management would lose a great deal. The central control department is the pulse of the plant and when the plant is small enough all details of planning, scheduling and dispatching can be performed there and one office can competently supervise the entire machinery of production. If the information were decentralized much extra effort, running around and possible duplication would result. Indirect savings are affected by centralized control.

(*b*) *Product.* There are, however, plants between these two types which may require decentralized control in some departments and centralized in others. In manufacturing watches and speedometers a central control is absolutely necessary so that requirements of each grade of product may be most economically scheduled through departments, processes or assemblies, and the product completed and available when needed in relation to other parts or assemblies. For some parts of sub-assemblies only the central control is needed; this is the case where automatic machines are adequate and where the operations are few and the foremen responsible for production. The physical means of control are the records of production against requirements and the balance of stores cards in the central control.

In punch work for example where parts are varied and set-up time is a consideration the situation necessitates departmental control and central control with balance records and graphs. In the assembling of a watch production control routine was reduced to a minimum by establishing central scheduling for gangs and by detailing the dispatching of the work of each operator from the central stockroom.

The type of product is a vital factor in determining the method of control. If the article is a technical one and is made mostly in one department there is no object in bringing the control back to central headquarters; the department heads know the problems and immediate situation much better than any central authority can know them and manufacture is entirely independent of other departments in the plant. The reverse is true in a small plant if the products pass through several departments and many products are fabricated on the same machinery. In such a case central control is absolutely essential for economical manufacture. In a large plant control by departments would be desirable while in a small one control would extend to individual machines or work places.

2. Process of Job System

Production and cost systems tie together to a very great extent and they should be considered one and the same thing. There are two principal methods of cost gathering: (1) process costs, (2) job costs. The process system is merely controlling production and costs by processes. The cost is secured by accumulating the total cost of the operation and dividing it by the number or amount of parts sent through. In the job or lot system each lot of parts has separate job tickets for each operation performed on them. In this way tight control and exact cost records are secured for each operation of each lot.

Whether a process or job system should be installed is largely a question of practicability. In certain industries, such as a paper mill or a blast furnace, it is impossible to secure exact costs of each operation of each lot. Lots are not separated and process costs only are possible. In many industries, although it is possible to secure job costs, this is not necessary or practical; only when they are easily available should job or lot costs be collected. However, it is possible to have a combination of both process and lot cost systems. In a tannery, for example, up to a certain point process control is best; then the lot system can be used, and finally process costs again. In a paper mill process costs can be used up to the finishing operation but from there on only job costs can be utilized.

3. Form of Organization

Many varieties and combinations of types of plant organization have been used in industry. Practically all, however, fall within one of four classes: (a) committee; (b) line; (c) staff; (d) functional.

(*a*) *Committee*. The committee system is extremely valuable where deliberative action is necessary. In this system a committee composed of the heads of the important divisions of the business performs the function of general administration. It brings together the best minds in the organization for frank discussion of problems as they arise and for decisions requiring definite action. Since the heads of departments have a voice in reaching decisions they will tend to cooperate in carrying out the decisions effectively. The weaknesses of the system are the lack of authority over individual members of the committee, the possibility of shifting responsibility, the often indefiniteness of decision, and the time which it may take to reach a conclusion.

(*b*) *Line*. The line form has its advantages in a stable business but in ordinary usage it is poorly adapted to meet emergencies. Usually one man is in active charge of all the departments of the business; his decision in all matters is final and he personally supervises all the work. This does not provide for complete coordination of effort between the various heads as each acts independently and is responsible only to the chief. An additional weakness is that each official covers both administrative and executive functions. Small organizations find this method very good because the weakness of lack of cooperation can be easily overcome by the personal touch.

(*c*) *Staff*. The staff type of organization is best where new problems of an expert nature are constantly arising. A group of experts, each one a specialist in some technical or non-technical branch of the business, is attached to the office of the higher executives. Whenever problems of a peculiar nature arise the best course of action is not left to the haphazard decision of a foreman but is delegated to an expert member of the staff. The precaution is unnecessary in an organization where such problems do not arise or where they come very infrequently.

(*d*) *Functional*. The functional organization is adapted to rapid changes. The supervision is divided by functions; instead of a foreman being in charge of all functions in his one department, the duties will be segregated and each duty or function will be controlled through the department or plant by one expert. Each specialist knows his function and can meet emergencies immediately and completely. Under this plan the manager need not bother about intimate details of the business; he can devote his energies to affairs of administration and policy. The sharp division into functions, however, makes it extremely necessary for the manager to supply the coordinating and stabilizing influence by calling frequent conferences of the functional heads.

An organization must be designed to meet the individual needs of the business. Many factors bearing on the industry must be considered in selecting the proper type of organization: size, location, personnel, product, and technical qualities. Even in the same industry a difference in methods or character of personnel may make it desirable to develop a different type of organization.

4. Labor Control

Labor control methods used must be adapted to the organization. The character of the management, owner, and labor all affect the choice of methods.

Different types may of necessity prevail in open and closed shops. Different forms of representation, shop committees, and works councils apply only in particular cases. Labor union policies may seriously affect the control system. Similarly, the general traditions of laborers or employees in the plant, for instance with regard to the proportion of union and non-union help working side by side, have much weight and influence.

The size of the plant plus the type of organization will determine largely the kind of labor control. Centralized labor control and records are desirable in smaller plants. Hiring, discipline, and discharge can best be handled in a central office under the employment manager. As the size increases or as the union situation becomes more complex it may sometimes be better to perform these functions in each unit or department, or work out a combination of partial centralization and decentralization.

5. Material Control

Part of the problem of production control is the control of materials. Certain definite policies for their handling must be determined. The size of the plant, layout, type of product and the materials themselves will all decide whether to have centralized or decentralized material storage, records, and replenishment. Smaller plants usually should have complete central control but in the larger plants the wisdom of high centralization is doubtful. In the latter cases centralized master records and control combined with decentralized issue or departmentalized storage and issue have been found most satisfactory.

The type of the product and kind of industry will influence the nature of balance records kept. The balance of stores sheet must be designed to fit and aid the particular type of production. Replenishment governed by the amount on hand in the storeroom is suitable only where there is a uniform rate or flow of materials. Replenishment on schedule is desirable where requirements for a considerable period in the future are known. Replenishment regulated by the amount available is effective in most plants where materials have a fluctuating rate of use.

In connection with material control, purchasing policies must be decided upon. Small factories will, no doubt, place all purchasing in the hands of one person. Larger organizations find it more desirable to distinguish between purchasing routine items, small in quantity and stable in price, and items which fluctuate in price, delivery, and sources of supply. The latter group present the problem of the extent of speculative purchasing that the concern will do. In case traffic conditions, price movements, sales tendencies, supply and demand, labor market, or the finances of the company indicate a change, a decision must be made as to whether the purchasing agent will be permitted to buy heavily or vice versa. It is also well to lay down in advance the extent to which the concern is going to do a merchandising business in addition to manufacturing, if at all.

6. Tool Control

The tool control problem is very similar to that of materials. The size of the plant, type of product and kind of machinery will largely determine the form of records and how they will be kept and where the tools will be stored, issued, replenished, maintained, designed and constructed. In small plants in which processes are simple a centralized system will suffice; however, when the plant is large or the products diversified and technical, very little advantage, if any, can be secured from centralization. If real standardization of tools is required it is much more easily attained and maintained under centralized control than under decentralized.

It is now obvious that no one system of production control can be applicable to all plants and industries. Each plant has its individual peculiarities and needs. The production system that serves a plant adequately must be designed and used according to the requirements of the particular plant. The general plan of attack is first to find out the facts of the business. Certain of these are permanent and others may be modified. In the light of these facts each problem or possibility of control can be decided upon and the proper methods developed.

III. What is Production Control?

PRODUCTION control is the preparation and administration of Work in Process.

The object of control is to secure the maximum use of facilities so as to satisfy the needs of sales, production, and finance. Through proper control, sales are materially aided since delivery dates can be specified accurately; production flow is regulated and made more continuous; delays are avoided, progress recorded, balances of work ahead kept, and in assembling industries the parts brought together at the proper time. All these factors aid in lightening the financial load by reducing work in process and costs, and among other things foster and form the necessary ground-work for better industrial relations.

A. The Work of Control

The general limits and requirements of production as well as those of sales and finance are outlined in the master plans. They will show which articles must be manufactured during a given period of time, the proper quantity and the design. These master plans are then broken down into detailed production plans, schedules, and budgets. From this point the work of production control starts.

The work of production control is divided into four functions. They are:

1. Development and preparation of plans.
2. Scheduling.
3. Dispatching and production.
4. Inspection and costs.

This division of work is typical of that used in the more progressive industries, and all of those functions in any event must be carried out by some one in every factory.

B. Bases of Control

"Control" implies predetermination of events before they occur. Such plans cannot be accurately made in advance and modified as work proceeds without having the proper foundation upon which to work. A factory cannot start manufacturing until it has equipment; neither can management plan and control production properly unless certain prerequisites for control are developed.

Too much emphasis cannot be placed upon the necessity of rigid standardization if economical control of any industrial undertaking is to be expected. The best way of performing work and enforcing it in practice until a better way be found must be determined. As a result most economical methods as regards time of operation, efficiency of operator, maintenance and standardization of work places and tools, and the elimination of unnecessary fatigue are developed.

Besides these bases the internal layout of the plant should receive considerable attention. The grouping, sequence, position, and general arrangement of buildings, departments, machines, and equipment individually and in relation to each other is desirable. Methods of storing, moving, and transporting materials besides methods of communication obviously must be predetermined if proper control is to be developed. All accounts and charges should be classified in a logical, systematic, and orderly arrangement. Control is made surer if the lines manufactured are reduced to as few fixed types and sizes as practicable. Economical power and its distribution to work places are also essential. However, an organization does not have to be completely standardized and controlled before securing any of the resultant advantages. Even a plant with a non-standard product can establish definite methods of processing and have some control over work in process. As these methods are developed many benefits will be secured long before standardization of the product is, if ever, attempted. Real production control and its benefits, however, will not be secured until all the bases of control are firmly established and maintained.

1. Development and Preparation of Plans

The development and preparation of plans demands the determination in advance of what to make, how to make it, where to process it, and when in general to do the work. The products which are selected by the master plans are designed in detail, and material specifications are drawn up with the ideas of simplification and standardization foremost in mind. To transform these materials into the finished articles the sequence of processing operations on each part must be outlined, and tools and machines best fitted for the performance of each of these operations indicated. Without labor properly selected and trained for these performances, no plan is of value. Having provided for the product, materials, labor, and tools, the planners must decide so far as possible upon the quantities or lot sizes in which the individual products are to be manufactured. When economical units of manufacture are scientifically determinable they are a boon to the industry if properly used and adhered to.

The layout of the plant will determine broadly where production will take place. However, in planning, departmental balance must be taken into account. If certain divisions have too great a number of operations or products to make, a slight revision will often relieve the overburdened sections. Also, besides picking out the best machines and work places, alternate machines and work places may be indicated. When the groups of product should be finished is determined by the master plan, but considerable leeway is given the production group in outlining the sequence in which the individual operations, lots, and products can be manufactured. Proper sequence brings with it many benefits. The master plans will be satisfied if items are completed when specified, and customers pleased by prompt or agreed-upon delivery. Equipment is used to its maximum capacity so far as work is available. Labor is systematically handled when plans are predetermined; last minute rushes are avoided or minimized; and more steady employment is provided.

In order properly to perform the function of development and preparation of plans the men responsible for planning must have considerable information. From the master plans, budgets and schedules are secured. The engineering department supplies the bills of material, drawings, specifications, and tools, and assists those planning to work out the operations, sequences, machines, and alternate machines. The planners must also know the capacity of the individual machines and departments, raw and other material required, character of labor, i. e., skilled, unskilled, or what proportion of each, relation of each part to the assembly, when inspections should be made, and the percentage of spoilage.

It is the duty of the preparation group to collect and use the data to determine what products to make first, how to make each, where to process them and when in general to do the work. From the master plans, which give the limits of money and time that can be used, the general schedule of manufacture is laid out. Together with the engineering department the preparation group has worked out the best methods and proper sequence so they are properly equipped to decide how to manufacture. They know what machines and departments are available and what material and labor can be utilized. The route clerk lists the various operations, assigns machines or work places and alternates and makes out the tool lists. The latter's assistants upon receipt of a manufacturing order proceed with the necessary paper work.

Stores issues are made out in advance and stores apportioned to the orders, or if stores are not available the purchasing agent is notified and orders placed for the requisite material. Routine clerks then make out all other forms such as operator's job tickets, move slips, bulletin board tickets, inspection tickets, route or progress sheets, identification tags, and instruction cards where these are necessary. All this advance paper work is collected and filed away in a route file by classification and symbol, until the time when the order is to be started.

2. Scheduling

Under the development of plans the general determination of when to do the work is outlined. It is the duty of the scheduling group definitely to decide the relative order in which all operations should be worked upon, and just when each should be started and finished. They have available all the information that the master plans and the preparation function have secured and formulated. In addition to this they must secure for themselves exact facts as to the orders and needs of customers; what materials are on hand or due on specific dates; the time required for each operation, including inspection, moving, and assembly operations; balance of work ahead at all times in hours or in units; and balance of labor of requisite skill available for each operation.

The schedule supervisors, who are subordinate to the development and preparation group start with the knowledge of when each order or lot is desired and must work out a method of action through which orders will be finished when desired, at the same time keeping a proper balance of work and of labor in the plant. Machines must be used as continuously as possible and labor must not remain idle. Materials, which have already been prepared, must be ready to be moved to the machine or department. The best available operators for the individual operation, together with alternates must be provided just as is the case with machines.

3. Dispatching and Production

Having settled upon the proper sequence of operations for each job, and having indicated so far as possible in advance when each operation should start and finish, it is the duty of the dispatchers working in close cooperation with the schedule men to see that the schedule is carried out as planned or revised as needed. If the schedulers, owing to the peculiar conditions of the plant, cannot definitely assign specific machines or labor to jobs, then it is up to the dispatchers to do so as soon as practicable.

Starting with the detailed schedule, the dispatchers must be provided with immediate and continuous records of progress, with records of machines and labor available, of quantity and quality of work produced, so that plenty of work (orders, instructions, materials, tools and so on) may be kept ahead, and revisions in the schedule made as necessary. Work cannot be economically started and carried through a shop in a haphazard manner; the methods must be worked out in advance if any sort of balance is to be maintained.

The detailed methods, of course, may be devised to fit the particular problems of the particular industry, but they all have the same object—that of putting work into a plant in an orderly fashion—and in many cases the experience and methods of one executive may be directly useful to another executive in a different line of work.

Some of the more familiar mechanisms by which this control is secured in different industries are planning or bulletins boards—which may or may not be in graphic form—graphic charts of various kinds, tickler systems, visible card indexes, and so on.

The whole function of scheduling and dispatching is a very difficult one since every factor and influence in manufacturing affects a predetermined schedule. The men in charge of this work must be of high calibre (particularly those who have to do with the scheduling) to sense in advance and avoid the pitfalls incident to high production.

Production, or the actual performance of the work, follows the dictates of the schedule as administered by the dispatchers. It is the duty of production officials to see that preparations for performance have been properly made and to direct and supervise the execution of them.

In order to function properly, the production group must have advance information regarding the work to be produced, the materials, tools, drawings, methods, wage plans, and all other necessary instructions. It is their job to check this information; they must be sure that they can carry out the plans as outlined. The material supplied must be of the proper specification and quality; the tools must be adequate and properly designed from the point of view of production as well as of engineering; drawings, together with detailed instructions as to methods and times of processing, as well as payment for work done, must be looked over and followed. Keeping the supply of labor up to requirements is primarily the duty of the preparation function, but the production men are in a position to assist in securing sufficient quantity of the right character of labor through selection and training of new employees.

The production group should supply the dispatchers with immediate and continuous records of progress with respect to all shop activities. Where desirable, this may be accomplished by providing job tickets, move slips, inspection tickets, etc., to be centrally issued and returned at each step in the work.

4. Inspection and Costs

Broadly, it is a function of inspection to see that all activities are being carried out satisfactorily. This means not only that work must be inspected for conformity to specifications, but also to see that performance in general is carried out in accordance with the instructions of the dispatchers. Thus both the quality inspectors and the production officials are concerned with the general inspection function.

The men responsible for quality inspection must work hand in hand with the schedulers and dispatchers, for it is only after the inspectors have passed upon the product that the dispatchers can continue with the processing. The inspectors must be furnished with the specifications and drawings showing the finish, tolerances and quantity, instructions as to methods, and properly calibrated inspection tools. In addition the inspector must have sufficient knowledge of the uses of the product to determine whether to scrap, repair, or pass doubtful cases. The foreman and other production officials must also be provided with all information and instructions for performance, so that general inspection can be maintained throughout the time of processing.

The cost department follows in the trail of production and collects the actual expenditures. It includes sorting and charging each expenditure against its proper account or classification. A system of production control, as indicated here, provides an easy and natural tie-up with costs. While performing the various functions outlined all the actual order or operation costs is made out as part of the preparation routine. It remains to tabulate and collect the various costs from the job tickets and other production records that are turned in daily by the various departments.

In conclusion, the object of production control is to secure the maximum use of facilities so as to satisfy the needs of sales, production, and finance. This is to be accomplished by means of careful and scientific preparation and administration of work in process, as outlined in this paper.

However, the mere setting up of functions and mechanisms will not necessarily produce proper production control. In addition to standardization and functionalization, personnel of high calibre is absolutely necessary. Men who think, and have executive ability, must be placed in control. Functions such as development and preparation of plans, scheduling, production and inspection all require men who are distinctly able and aggressive. Again, even with the proper type of personnel in the functions, best results are obtained when these men are tied together through a logical form of organization so that they work and cooperate as one harmonious group.

IV. The Value of Production Control in Industrial Management

IT WOULD be difficult to find a manufacturer who does not believe in some kind of planning or production control or has not put into operation a control plan in his own industry. It is for the purpose of checking up the value of present methods of production control that this paper is written.

A. Turnover

Manufacturing executives of large and small industries are continually confronted with the problem of inventory turnover time. Of this all-important subject it is sufficient to say here that the length of turnover time in a manufacturing plant depends largely upon a proper system of production control.

Manufacturers are successful or otherwise according to the quality of the service supplied the public, and the measure of this service is the price and quality of the product in comparison with competing industries. Inasmuch as time is the thing that all manufacturers pay for in raw materials and finished product, it is advisable to arrange manufacturing methods so as to shorten the time of manufacture to a minimum as the consumer will buy where he receives the most for his money.

B. Inventory

The safest way to use money in manufacturing is in an endeavor to follow a carefully worked out budget of quantity production for a fixed period. Any plan that is not built up on the knowledge of factory capacity encourages unsystematic manufacturing which has proven itself to be exceedingly wasteful in the use of capital. Much money has been frozen up in materials and equipment and only liquidated over long periods; in many instances it has eaten itself up in interest charges or become obsolete through changed conditions.

In industry there is much loss through waste of both raw and worked material, the latter causing much labor waste. The greater part of wastes such as these are chargeable to a near-sighted policy, or to put it straight, to the myopic greed of some managers. A long list of conditions that generate wastes of various kinds in manufacturing can be enumerated, but the one primary cause is the unwillingness of management to remove their blinders so that they may see in more than one direction. The demoralizing influence of the preventable waste in men, money, machines, material and management on the mind of the worker, honeycombs the entire organization, and thus high cost of manufacture is perpetuated with the result that the public bears the expense.

C. Indirect Expense

It is the fear of too much indirect expense that causes executives to hesitate in setting up adequate control methods at the source where they should be. Because of this fear, they try to control by historical records taken from controlling accounts, always after the loss has been taken.

With a proper system of production control, a true picture of direct and indirect expense will be obtained and the ultimate and relative value of both will be shown. Without such a system it is not possible to appreciate the value of the indirect labor or to know whether there is enough or too much. The only sure thing is that it exists whether it shows or not. A true system of scientific production control uses the minimum amount of indirect labor to the maximum advantage, which is impossible without this control. If indirect labor can create more economical manufacture by extending expert service to direct labor, that will cause a greatly increased production. Then such expense is no longer chargeable to burden, but is a powerful economic factor in production.

D. Production

A production control department was developed in a large business in which the control of production had been left largely to the foremen of the production departments with the result of an unbalanced inventory, a long time turnover, and many other expensive wastes. By the introduction of a central control of production based upon a six months' schedule from the selling department the length of turnover has been reduced by several months with the certainty that it will be further shortened. Over a term of ten years the number of major unit assemblies of the product was from 650,000 to 750,000. After the control methods had been in operation seventeen months the number of these units in the flow were reduced to 358,500 and the turnover time of sixteen to eighteen months shortened to seven to nine months. With an average inventory of 740,000 major assemblies units in the stream, 2100 units a day were delivered from the factory to the sales department compared with 358,500 units in the stream and a delivery of 2275 units a day from the factory to the sales department. The 740,000 units in the flow required 4000 people, while the present flow of 358,500 necessitates a personnel of only 2500. By this method of control the inventory was liquidated—without loss—$1,803,689.22 in 17 months, or at an average of $106,100 a month and the carrying charges reduced $9000 in interest per month.

E. Purchasing

By the tying-in of the purchasing with the production control department great reductions in the amount of direct and indirect materials carried in stock, such as raw materials, supplies, etc., were secured; whereas under the old system each department head purchased according to what he figured his own needs to be against the orders he received for production.

The materials and supplies inventory account was reduced in 17 months approximately $5,000,000. This, of course, is included in the liquidation stated above.

The clerical force necessary to control the production had not been increased by this centralizing of the control. By the former decentralized control each department employed its own clerks and in many cases there was an excessive number of clerks.

F. Costs

While the indirect expense as a whole was not reduced very much, the direct costs were reduced considerably. Correct standards of production, based upon time study, which were centralized under one head, were set up, thus avoiding differences that existed in rates for the same skill in the several different departments as well as setting a correct standard based upon scientific time study. By this method of production control many processes that were expensive were discovered and changes made which have broken down dams and allowed the production stream to flow unobstructed within much more economical limits.

G. Esprit de Corps

With the introduction of control methods the esprit de corps of the organization was greatly improved inasmuch as an increasing number are working with the purpose of economical production. Employees were given more even and steady employment. Credit could be given to those who deserved it since responsibility for each job was made definite and failures easily noticed. Employees can sense this fact immediately and beneficial results ensue.

The Achievements of Motion Psychology

(*Continued from page* 259)

methods for measuring the elements of motion psychology, in other words, behavior.

This work is not, as is perhaps thought, the work of one person, one group or one country, although the devices were invented, perfected and first publicly demonstrated in America in 1912.[4] This work has been going on both in psychological laboratories and industrial plants in America, Europe, Asia and Australia for several years, and South Africa has also made a beginning.

Investigations have not been divided arbitrarily into various parts, these being assigned to psychologists, physiologists, psychiatrists, managers, etc., but have rather consisted of putting the methods of measurement at the disposal of all those interested in the human sciences and correlating the data resulting from their investigation.

Many artificial distinctions such as that between adult psychology, psychology of children and the psychology of animals disappear in such investigations, as do the distinctions between the various schools of psychology and the various schools of management. Facts are facts, and they should be presented in the errorless indisputable form of the photography of time, motions and the attending conditions, recorded simultaneously. Facts are quite distinct from interpretations of facts, and the insistence on The One Best Way to Do Work as the primary goal of investigations removes both personal prejudice and a temptation to that most subtle form of intellectual dishonesty, the use of facts to prove a theory when the most that they justify is the indication of a trend.

Some actual results in the field of industrial psychology during the past twenty years are:

1. The discovery of units in which to record the elements of behavior.
2. The invention of methods and devices for recording behavior in indisputable form.
3. The recognition of the wisdom of selecting the best man obtainable, in order to obtain behavior norms.
4. Errorless records of motions in three dimensions showing path, acceleration, retardation, times, relative times, distance, relative distance, speed, relative speed, direction and the relativity of simultaneity of the therbligs or elements of a cycle of motions.
5. The determination of The One Best Way to Do Work before it ever has been demonstrated, by synthesis of the best obtainable therbligs.
6. The recognition that all workers have three motion methods, (a) when in a hurry, (b) when working leisurely, (c) when teaching a beginner.
7. Records showing that fast motions and slow motions cannot be made in the same path.
8. Records of automaticity and its effects upon skill.
9. Records of effects upon automaticity and the resulting loss in output and increased fatigue of slight changes in one therblig or element of a cycle of motions.
10. Indisputable records of habit and of habit interference.
11. Records of decision, indecision, hesitation and fumbling, and the effects upon resulting motions.
12. The effect upon habit, motions and the transfer of skill, of tools designed and built to the shape of wear in use.
13. Records showing the correlation of calendar age with mental age.

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[4] Transactions of the American Society of Mechanical Engineers, paper No. 1378, discussions by John G. Aldrich and Robert T. Kent.

14. Records showing learning capacity,—a most important factor in mental development.

15. Records of efficient and inefficient learning processes.

16. Recognition of the economic importance of teaching right motions first, to all learners.

17. The new knowledge resulting from leisurely examination of stereoscopic motion pictures in a magazine stereoscope.

18. Records showing both general and special aptitudes.

19. The recognition that maximum desire for a special job and a determination to succeed at it are better prerequisites for placement at that job than a high I. Q.

20. Effect of the immediate incentive upon the motions of the demonstrator.

21. Relation of the amount of bonus above the going day rate and the hearty cooperation and adoption of The One Best Way to Do Work.

22. Proof that the Three Position Plan of Promotion, where each worker is learner and teacher, is a satisfactory incentive for continuous effort.

23. Records of fatigue, and its general and specific effects.

24. Records of rhythm which show the individual rhythm of activity, that concern relative lateness of the therbligs as well as muscle impulses.

These twenty-four specific results of the investigations outlined by no means cover the field, but indicate the results that have actually been achieved in motion psychology and the type of results that may be expected in the future.

The great psychological laboratories are still to be heard from in motion psychology. The achievements above listed are largely the result of investigations by engineers for immediate practical results.

It has been proved that nothing of great value in psychology, in management or in the correlation of the two can be expected when problems are generalized, when investigations are indefinite or when a solution that seems to have worked well on one problem is applied to another, without thorough investigations as to how far the elements of the two problems are identical.

Such problems as Dr. Person mentions,—problems of selection, placement, training or teaching, promotion, incentives, maintenance,—these all demand solutions depending absolutely upon an accurate knowledge of and proper presentation of The One Best Way to Do Work of the activity involved,—a knowledge which is essential both to psychologist and manager.

The findings above listed indicate the value of the data obtained when used to solve the very problems suggested. The twenty-four might well have been grouped as they apply specifically to problems of teaching, incentives, promotion, etc., with special stress on teaching.

Too much stress can hardly be laid on the fact that the great defect with most training plans in the past has been that the trainers did *not* have a knowledge of The One Best Way to Do Work, and depended upon obsolete methods for teaching such methods as they did have.

Cooperation between managers and psychologists is constantly increasing. In the past there have been many delays caused by the lack of a common vocabulary. Such delays still occur.

In the past the specializing psychologist has not always been able to estimate the work of the manager correctly, nor has the manager always been able to estimate the work of the psychologist, as Dr. Person has said. In some cases there has been belittling of the work,[5] and in other cases there has been over-estimate.[6] Any type of cooperation between managers and psychologists of any school will do much to overcome these handicaps, but most is being done where psychologists and managers are contributing their diverse training and equipment cooperatively to the solution of definite, isolated elementary problems, and where the results are being applied by those specially trained in the transference of skill.

Such investigations as are here outlined in nowise interfere with intelligence tests, provided the tester is intelligent, the use of the questionnaire, "brass instrument psychology," or any other type of investigation. Rather they act as necessary supplements, in that they furnish motion or behavior records of the subject being examined by any method, which are invaluable when the data are being reviewed.

Nor does the work being done in industry in anywise interfere with the work being done outside industry, whether in laboratories, institutions of any type, or any other place where research is going on. Records of champions, of experts, of amateurs, of bunglers; of super-normals, of normals, of sub-normals; of morons; of epileptics in seizure; of the handicapped,[7] physically and mentally,—all these are now available. All can be brought to bear upon the individual whose case is being studied, whether the problem be adjustment, training, promotion or any other of the numerous problems that industry affords.

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[5] Discussion of "Stop-Watch Time Study," ***Bulletin of the Taylor Society***, Vol. VI, No. 3, June, 1921.

[6] "The Efficiency Engineer and the Industrial Psychologist," by Dr. Charles Myers,—***Anals of Institut d'Orientacio Professional***, Barcelona, June, 1922.

These statements may seem revolutionary and theoretical when compared to usual practice in this country today. They are neither. As for practice abroad, both psychology and management in this country, especially in the field of industry, are suffering because of ignorance as to the great advances that are taking place abroad. This is, of course, the natural result of self satisfaction and the worship of a tradition. Throughout many countries, as we endeavored to point out in a paper presented before the Taylor Society in January, 1924,[8] it is customary for all possessing knowledge of the human sciences to cooperate on investigations for the betterment of industry. Even where such cooperation does not as yet actually exist, because neither psychologists not managers are adequately trained, the necessity for such cooperation is recognized, and the best existing practice in both fields, internationally, is being studied and utilized.

Kent, Farmer, Myers, Muscio, Spooner, Vernon and many others in England; Castella and Mira in Spain; Volmer in Holland; Finnbogason in Iceland; Westergaard in Denmark; Cavrot in Belgium; De Freminville, Amar, Lahey and Ottenheimer in France; Moede, Piokowsky, Schlesinger, Sachsenberg and Witte in Germany and the great scientists at the Zeiss works; Remane in Switzerland; Basta, Bezant, Klir, Kottland, Rezek, Spacek, and many others at the Masaryk Academy in Czechoslovakia; Uyeno in Japan,—all these and many others in many countries in some way interested in the human sciences are advocating such close cooperation, and are practicing it so far as is possible.

The basis of such cooperation consists of accurate and indisputable records of actual behavior or motion. We have been asked many times why we are so bitter in our opposition to half way opportunist methods of making and using records in industry. One reason for this opposition is the fact that such records are *absolutely useless* to psychology, and are a detriment to the advance of psychology in industry. They are misleading to the young students in the industries, and they furnish that which must be unlearned by the graduates of our great institutions of learning. The colleges are unintentionally deceiving their pupils. The faculties of but very few colleges know anything about The One Best Way to Do Work and their teachings unfit their pupils for immediate usefulness in the industries.

Therefore, we believe that a universal acknowledgment of the necessity for records that embody accurate, indisputable measurement and that can be used by the man who was not present when the work was made is essential, as a basis for satisfactory work in both psychology and management. Also, that preliminary to such work as Dr. Person outlines would be accurate survey, international in scope, and covering the field of all the human sciences, showing what is already being done in the field of industry to bring together psychology and management—for the advance of science and the furtherance of human betterment.

Reviews

An Introduction to the Psychological Problems of Industry. By Frank Watts, Macmillan, 1921, pp. 240.

There has thus far been no American book dealing with the application of psychological principles and psychological knowledge to all the problems of industrial management. There have been specialized psychological discussions of advertising, selling, selection, training, and the like; but as yet it is impossible to find in one volume a critical consideration of management problems in the light of the best modern psychological scholarship. Professor Watts' book supplies this need in a remarkably effective way, when it is considered that it is written with an English setting and that it confines itself exclusively to the human problems of industrial organization, and omits all consideration of advertising and selling. Indeed, nowhere else is there yet available between two covers such a clear, accurate and persuasive statement of the uses to which psychological knowledge can be put by managers. While not exhaustive, the treatment covers effectively the fields of fatigue and its elimination, vocational selection, scientific management problems, the nature of industrial unrest, problems of monotony, and a brief critical consideration of the various plans of industrial reorganization from the point of view of the opportunity they offer the rank and file of humanity for satisfactory self-expression and personal happiness.

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[7] See Gilbreth, "Motion Study for the Handicapped," E. P. Dutton & Co., New York.

[8] See "Scientific Management in Other Countries than the United States," *Bulletin of the Taylor Society*, Vol. IX, No. 3, June, 1924.

Until some American psychologist can mobilize American experience and American thinking on these problems into a first-rate industrial psychology, Professor Watts' book will stand as the indispensable contribution to this field which no serious student of the managerial science on its psychological side can be without.

The objection to literature of this type will, of course, be made that it is merely putting into high-sounding language an emphasis upon a humanistic and personal attitude toward management problems which is already being urged by those who realize the importance of the personnel aspects of the administrative science. Yet in reality, more than this human attitude is provided and reinforced by industrial psychology, because in the handling of problems of selection, training, monotony, leadership, morale-building and the like, psychological knowledge points the way to a definite effective technique. To be sure, Professor Watts does not offer a presentation of adequate technique on all these subjects, but he makes a better start toward this than any other writer has yet done.

ORDWAY TEAD.[1]

Labor Attitudes and Problems. By W. E. Atkins and H. D. Lasswell, Prentice-Hall, Inc., New York, 1924, pp. 520.

As we make advances in science it becomes obvious that the problems over which we studied hard and long could have been solved with ease had we then had the knowledge we now possess. In many cases we have had the cart before the horse, and although we finally solved the problem we were late in making our decision, in fact in many instances too late. Why? Because we did not get at the fundamentals. One must creep before he walks and walk before he runs. So it is with science, and the handling of labor with all of its ramifications is a science.

The authors, when they said of this work, "It is an attempt to understand the worker from an economic standpoint, what he does, how he lives, what he thinks, in brief to get at his attitudes," hit the nail on the head insofar as labor problems are concerned except they should have added in substance, "and learn the reasons for these attitudes." For until we learn the attitudes and the reasons for them we are not in a position to deal intelligently with the problem. The tendency has been, and in some quarters still is, to give more attention to machinery than to men, and only in recent years has the man problem been given anything like the attention and study it deserves.

In this most commendable work of approximately 500 pages the authors have in simple, readable, easily understood and well chosen language gone to the soil beneath the roots of the plant to get at the problems of the plant growth and development. For the student the book is the best of its kind I have seen, and is also of great value to those actively engaged in industrial relations work, for although it may not contain so much that is new to the experienced it is so arranged as to be interesting as well as valuable for reference and study. The practical questions at the end of each chapter serve to promote right thinking along the line of industrial problems of daily occurrence.

The book contains a logical presentation of fundamental facts along the lines of environment, standards of living, etc., of both skilled and unskilled, male and female operators in many lines of endeavor, including coal miners, steel workers, agricultural groups, clothing workers and casual laborers; also an illuminating description of the development of the machine industry and its effect on economic conditions. It treats fairly and impartially of the subject of unionism, its extent, organization, policies and tactics, as well as underlying forces and struggle for status. One chapter is devoted to the live subject of unemployment, its history and remedies.

The concluding chapters deal with "the assertion of public interests" under the following headings: 1. Arousing community action; 2. Mechanism of public control; 3. The objectives of community action, thus recognizing that the community is an essential party to industry. All in all, the authors have presented a practical work in a practical way for the use of the practical man as well as the student.

EDGAR D. SEBRING.[2]

Factory Management. By Henry Post Dutton,[3] The Macmillan Company, New York, 1924, pp. 329.

In his preface, the author of this book says: ". . . It has been the author's purpose to give as nearly as might be, a balanced description of the operation of the various departments of the factory, to show their relation to each other and their problems as part of the greater problem of coördinating all activities of the organization toward the accomplishment of the single general purpose." That he has succeeded in accomplishing his purpose will undoubtedly be the opinion of the large majority of his readers.

The book *is* well balanced and the relationship of the various elements and functions that enter into and are concerned with the conducting of an industrial enterprise *is* nicely established. Furthermore, there is a wise exposition of the principles upon which this relationship depends, accompanied by examples and descriptions of the methods to show how these principles are made effective.

"Factory Management" is not an exhaustive treatment of the subject, and probably the author did not intend it to be. Therein lies its value. If one wishes to learn in detail of the work of the purchasing agent or the personnel director, or the job of plant arrangement and layout, or expects to find ready-made a system of production control worked out to the last item, let him turn elsewhere. If one reads the chapter, "Time and Motion Study," and intends thereby to become fitted for time study work, he will indeed be ill equipped for the job, but he will have secured an appreciation of what the job calls for and how it should be approached, of the part that time study plays in manufacturing, of the necessity of control of auxiliary functions, and an understanding of how in general, studies are made and standard tasks determined. Such is the treatment the author gives to most of his chapters. The result is the painting of a background, the statement of fundamentals that lie behind good management, but that to be completed in detail must be supplemented by additional study.

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[1] New York School of Social Work.

[2] Personnel Manager, Corona Typewriter Company, Inc., Groton, N. Y.

[3] Associate Professor of Factory Management, Northwestern University School of Commerce.

The development of the book is based on the philosophy that control is the key to successful management. Each problem has been approached from that point of view, and the various methods and theories pertaining thereto have been brought together and application made. His choice of examples of methods of control and illustrations of these was apparently based on simplicity and clarity. They show sufficient detail and yet are not encumbered with the unusual. They fairly represent the average situation.

Production Control constitutes the major portion of the book. In fact, sixteen out of the nineteen chapters cover subjects that deal directly with production or are closely allied functions, such as accounting, personnel work, purchasing, etc. The other three chapters cover financing, selling, and organization and executive control. These last briefly indicate the jobs of financing and selling as well as the relation they bear to the job of producing, and the problems of general organization and administration.

The other chapters deal with manufacturing design, plant and equipment, layout, time and motion study, purchasing, stores, planning, scheduling, types and plans of production control, accounting and costs, supervision and inspection, personnel, wage payment, and industrial relations. In each instance the functions of the departments, or elements of the factors under discussion, are defined in terms of the job itself, but throughout is woven the thread of control and each is shown to have its part in the general scheme of control.

In addition to the text, Mr. Dutton has made a valuable contribution to teachers of management by the dvelopment of a series of problems so set up as to apply to the various chapters of the text. These cover practically all the phases of management discussed by the author and in the main refer to the operations of a single organization making a simple product, so that there is a coherence and uniformity of purpose throughout.

In conclusion, the book should recommend itself to those who desire a simple and easily understood survey of the factors that make for control of the various operations within a manufacturing enterprise.

N. G. Burleigh.[1]

Planned Control in Manufacturing. By William O. Lichtner,[2] The Ronald Press Company, New York, 1924, pp. 329.

This book is a companion volume to Mr. Lichtner's previous volume on "Time Study and Job Analysis." The earlier volume deals with the steps involved in investigation and standardization. This new volume deals with the office and administrative sides of planning and control.

Mr. Lichtner's two volumes, taken together, constitute a most complete presentation of the "how" and "why" of Taylor philosophy and systems of management as evolved within recent years to meet conditions and methods of present-day administration. Although abounding in cases and examples adapted to the small as well as the large undertaking, the author is careful to repeat frequently that the methods and forms cited must not be considered as fixed or arbitrary.

The engineer or executive engaged in production will find in these two volumes of Lichtner's much that is needed to fill in the gaps left vacant in Taylor's "Shop Management," and in the writings of subsequent authors. That Thompson and Lichtner are engineers of long standing and that they have successfully introduced the methods described during a period of many years are in themselves a guarantee of the practicability of the philosophy, policies, and methods enumerated.

The following extracts from the book are indicative of the manner of treatment.

"Planning is the managerial function of working out the best combination of procedures through coordinating the requirements with the facilities for carrying out the work of the division. Control is the managerial function of putting these procedures into effect. The combination of planning and control forms a function which is necessary to, and links together, each of the four divisions.

"The term 'scientific management' is used in this book to characterize that form of organization or procedure which results from thorough investigation of manual and machine processes, materials, tools, equipment, and physical and psychological operating conditions—thereby making it possible to establish a basis of principles and laws which standardizes operations and provides for instruction in new methods of execution and which develops and maintains precise and automatic control, including the organization of the personnel, the processes, the materials, and the equipment in such functional cooperative relations as will utilize the highest technical skill available and capable of development in planning, supervising, and executing.

"This definition divides scientific management into two distinct phases—the first is job standardization; the second is planned control. Both are equally important. Neither in theory nor in practice can one be completely divorced from the other without serious loss. They are inseparable in the ideal conduct of any manufacturing enterprise. Under planning and control the first crude standards are set.

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[1] Professor of Business Organization and Management, Amos Tuck School of Administration and Finance.

[2] Consulting Engineer; Member of Firm, The Thompson and Lichtner Company, Boston.

The crude standards are refined by job standardization through time study and job analysis. Through planned control the detailed standards are maintained. The two elements work together for a single purpose—to increase the effectiveness of the employee and to lower the cost of production. In treating job standardization we are looking at the process of manufacturing from the point of view of the factory; in considering planning and control we are, so to speak, in the office."

HUGO DIEMER.[1]

The Economics of Overhead Costs. By John Maurice Clark.[2] The University of Chicago Press, Chicago, Ill., 1923, pp. 502.

The author states that "our study of overhead cost will be largely a study of unused powers of production." This thought, the central one in the book, has been carefully analyzed and forcefully presented. No effort apparently has been spared in developing the many phases of this subject. One might be led to the conclusion that a book of this nature would be theoretical in character but such is not the case. Many of the facts presented and the conclusions reached are based upon actual studies of business conditions. A perusal of the pages of this work will undoubtedly benefit the student, the engineer, the accountant and those entrusted with the job of eliminating overhead losses occurring through failure to utilize plant capacity fully. A sympathetic attitude toward some of the problems of the engineer, the accountant and the economist is in evidence throughout.

We are told that the idea of expenses of production is a rather recent one. Parallels have been drawn between the old handicraft system and the present machine system; between the old fashioned many price system and the one price system, and attention is called to the resulting change which has taken place in the character of overhead costs. The introduction of the machine into our economic life and the resulting keenness of competition has been instrumental in furthering the study of overhead costs and in developing the subject of cost accounting.

The problem of overhead costs and unused capacity is complicated. When must overhead costs be counted as costs and when must they be regarded as other than costs? What effect does the size of a plant or standardization have upon costs? Should industry recognize that the bulk of its costs are overhead costs and act accordingly in times of depression? How should overhead costs be apportioned? These are but a few of the many questions which come within the scope of the problem and to which the author attempts to find the answer.

There are a number of chapters which ought to appeal to the cost accountant. Most of the cost accounting literature has been written by cost accountants for other cost accountants and students of accountancy. Here the cost accountant is permitted to look at his subject through the eyes of an economist. Sections are devoted to discussions covering the standpoints and purposes from which costs are viewed; the different classes of costs such as fixed, constant, variable, differential, residual, urgent, postponable, shutdown, ultimate, joint, etc.; interest as a cost; different costs for different purposes; the unit of cost; the methods of allocating costs such as the accounting, statistical, and the estimated. Chapter XII is given over to a discussion of the Purposes and Methods of Cost Accounting; Chapter XVII to Overhead Costs in Special Industries and Chapter XVIII concerns itself with Labor as an Overhead Cost. Cost accounting involves more than the mere technique of accounting for material, labor and burden. There are other problems of major importance which influence the technique of cost accounting and the author seems to have discussed most of them in this volume.

The relation between overhead costs and the workings of economic laws is discussed in Chapters IV and V. The law of return and the law of proportion of factors are stated and analyzed. Mention is made of twelve variables governing efficiency which in turn is reflected in overhead costs. The effect of large scale production on overhead costs is covered in the chapters on "How and Why Large Plants Bring Economy" and the "Economies of Combination."

Specific problems in overhead costs in certain industries are ably presented. The cost problem confronting transportation companies and other public utilities is not easy of solution. Many factors influence costs, such as density of traffic, fluctuating demands, road-bed difficulties, development of off-peak business, terminal cost, difficulty of apportioning costs, effects of competition, and difficulty of allocating costs.

After reading this volume one cannot help but realize that, after all, overhead is a very important factor in the modern business world and that success or failure very often hinges on the way the overhead problem is handled. Overhead problems are difficult of solution and the executive, the engineer, the accountant or economist who is interested in these problems will find that a reading of this book will be a worth while investment.

J. LOCKWOOD.[3]

NECROLOGY

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Objects of the Society

(Extract from the Constitution)

The objects of this Society are, through research, discussion, publication and other appropriate means:

1. To secure an understanding and intelligent direction of the principles governing organized effort for the accomplishment of industrial and other social purposes for the common benefit of

   A. The Community
   B. Labor
   C. The Manager
   D. The Employer

2. To secure the gradual elimination of unnecessary effort and of unduly burdensome toil in the accomplishment of the work of the world.

3. To promote the scientific study and teaching of the principles governing organized effort, and of the mechanisms of their adaptation and application under varying and changing conditions.

4. To promote general recognition of the fact that the evaluation and application of these principles and mechanisms are the mutual concern of the community, labor, the manager and the employer.

5. To inspire in labor, manager and employer a constant adherence to the highest ethical conception of their individual and collective responsibility.

Membership

Members are elected by the Board of Directors. Applicaton must be made on a form which may be secured of the Managing Director. There are five classes of members:

1. Honorary Member: Elected for distinguished service in the promotion of the science of management.
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A Management Engineers' Creed

The sublimest duty of the engineer is to keep the faith:

The faith of the client that he will not undertake what he knows to be beyond his ability; and that with respect to what he undertakes he will give conscientious service to the limit of his ability;

The faith of his fellow engineers that he will remain true to his science and will magnify and not cheapen it; and that he will base his efforts for public recognition upon ability, scientific attainment and actual performance, and not upon ambiguous self-laudation;

The faith of the community that he will undertake no service inconsistent with the public welfare and that in service consistent with the public welfare, but in which the interests of groups appear to come in conflict, he will judge carefully and sympathetically the claims of rival interests, and attempt to establish that unity of purpose which promotes the public welfare.

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